United Nations

Framework Convention on
Climate Change

FCCC/SB/2015/INF.1

Distr.: General
4 May 2015

English only

Subsidiary Body for Scientific and Technological Advice
Forty-second session
Bonn, 1–11 June 2015

Item 6(b) of the provisional agenda
Matters relating to science and review
The 2013–2015 review

Subsidiary Body for Implementation
Forty-second session
Bonn, 1–11 June 2015

Item 12 of the provisional agenda
The 2013–2015 review

Report on the structured expert dialogue on the 2013–2015 review

Note by the co-facilitators of the structured expert dialogue

Summary

This report summarizes the face-to-face dialogue between over 70 experts and Parties on: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention; and the overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention. It includes a technical summary and a compilation of the summary reports on the four sessions of the structured expert dialogue (SED). The technical summary synthesizes the work done by the SED and includes 10 messages capturing the key findings from its sessions.

Contents

		Paragraphs	Page
I.	Introduction	1–5	3
	A. Mandate	1	3
	B. Scope of the report	2	3
	C. Possible action by the subsidiary bodies	3	3
	D. Background	4–5	3
II.	Technical summary – proceedings	6–11	4
III.	Technical summary – dialogue	12–115	5
	A. Overarching considerations regarding the long-term global goal	15–27	6
	B. Theme 1 of the review – the adequacy of the long-term global goal in the light of the ultimate objective of the Convention	28–58	11
	C. Theme 2 of the review – overall progress made towards achieving the long-term global goal, including a consideration of the implementation of the commitments under the Convention	59–105	21
	D. Consideration of strengthening the long-term global goal, including in relation to a temperature rise of 1.5 °C	106–115	30
IV.	Concluding remarks and possible next steps	116–122	33

Annexes

		Page
I.	Summary report on the first structured expert dialogue on the 2013–2015 review	35
II.	Summary report on the second meeting of the structured expert dialogue	44
III.	Summary report on the third meeting of the structured expert dialogue	62
IV.	Summary report on the fourth session of the structured expert dialogue	109
V.	Statistics regarding the organization of the structured expert dialogue	180
VI.	List of experts participating in meetings of the structured expert dialogue	181

I. Introduction

A. Mandate

1. At their forty-first sessions, pursuant to the mandate for a structured expert dialogue (SED) on the 2013–2015 review given in decision 1/CP.18, paragraph 86(b), the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI) requested the co-facilitators of the SED to prepare, with the assistance of the secretariat, a final factual report that includes a compilation and a technical summary of the summary reports on the meetings of the SED and to make it available no later than 3 April 2015.[1]

B. Scope of the report

2. This report summarizes the face-to-face dialogue between over 70 experts and Parties that took place between June 2013 and February 2015 on: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention (theme 1 of the 2013–2015 review); and the overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention (theme 2 of the 2013–2015 review). It includes a technical summary of the work done by the SED, as well as the key findings from the SED meetings, as documented in the summary reports thereon. The technical summary features four sections: overarching considerations regarding the long-term global goal; theme 1 of the 2013–2015 review; theme 2 of the review; and consideration of strengthening the long-term global goal, referencing various matters presented by science, including in relation to the warming of 1.5 °C above pre-industrial levels. Annexes I–IV contain the summary reports on the four SED sessions. Annex V contains some statistics on the organization of the SED, while in annex VI, a list of experts who participated in the sessions of the SED can be found.

C. Possible action by the subsidiary bodies

3. The SBSTA and SBI are invited to consider this report in their deliberations on further steps to be taken in relation to the 2013–2015 review, including the recommendation of a draft decision for consideration and adoption at the twenty-first session of the Conference of the Parties (COP), pursuant to decisions 1/CP.16, paragraph 139(a), and 2/CP.17, paragraph 158.

D. Background

4. COP 16 recognized "that deep cuts in global greenhouse gas emissions are required according to science, and as documented in the *Fourth Assessment Report* of the Intergovernmental Panel on Climate Change, with a view to reducing global greenhouse gas emissions so as to hold the increase in global average temperature below 2 °C above pre-industrial levels, and that Parties should take urgent action to meet this long-term goal, consistent with science and on the basis of equity".[2] The COP also decided to periodically review the adequacy of this long-term global goal in the light of the ultimate objective of the Convention (theme 1 of the 2013–2015 review), and overall progress towards achieving

---

[1] FCCC/SBSTA/2014/5, paragraph 53, and FCCC/SBI/2014/21, paragraph 116.

[2] Decision 1/CP.16, paragraph 4.

the long-term global goal, including a consideration of the implementation of the commitments under the Convention (theme 2).[3] The 2013–2015 review was also tasked with the consideration of the strengthening the long-term global goal, referencing various matters presented by the science, including in relation to a temperature rise of 1.5 °C.[4]

5. The COP carried out the 2013–2015 review with assistance from a joint SBSTA/SBI contact group. COP 18 established the SED to support the work of the joint contact group and ensure the scientific integrity of the review through a focused exchange of views, information and ideas.[5]

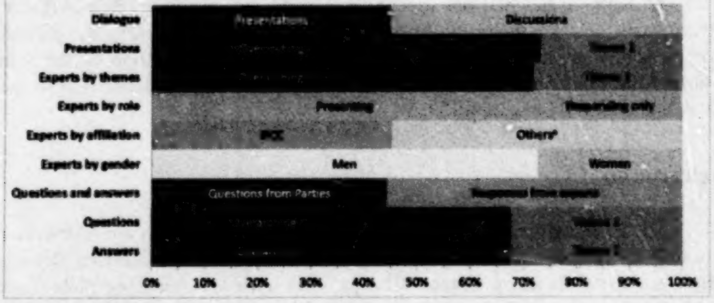
II. Technical summary – proceedings

6. The SED has held four sessions (five meetings) since its inception. These sessions were held in conjunction with sessions of the subsidiary bodies, and were open to all Parties and observers. The first session of the SED (SED 1) aimed to increase the understanding of existing scientific knowledge and explore how this knowledge could be used to address the two themes of the 2013–2015 review. SED 1 featured presentations by the World Meteorological Organization (WMO), the Intergovernmental Panel on Climate Change (IPCC) and the Hadley Centre for Climate Prediction and Research (HCCPR). The second session of the SED (SED 2) and the third session (SED 3) focused on the contributions of Working Groups I, II and III to the IPCC Fifth Assessment Report (AR5). The fourth session of the SED (SED 4) addressed the salient findings of the AR5, as reflected in its Synthesis Report; the key findings of reports prepared by United Nations agencies; the work done in relevant processes under the Convention; and regional and emerging information.

7. The SED sessions were organized as fact-finding, face-to-face exchanges of views between Parties and experts. The sessions were balanced in addressing the two themes of the review: an equal amount of time was allocated to each theme and both themes had similar formats (figure 1 and annex V). The organization of sessions took into account the 20 submissions of views from Parties and observer organizations.[6]

Figure 1

Statistics regarding the organization of the structured expert dialogue sessions



Note: "Overarching" connotes relevance to both themes of the 2013–2015 review.
Abbreviation: IPCC = Intergovernmental Panel on Climate Change.
[a] See paragraph 8 and annex VI for the affiliation of other experts.

---

[3] Decision 1/CP.16, paragraph 138.
[4] Decision 1/CP.16, paragraph 139(a)(iv).
[5] Decision 1/CP.18, paragraphs 85 and 86.
[6] Available at <http://unfccc.int/7590.php>.

8. Pursuant to decision 2/CP.17, paragraph 161, the SED considered:

(a) The contributions of all three working groups to the AR5, and its Synthesis Report;

(b) The work of following processes and bodies under the Convention: the Adaptation Committee, the Climate Technology Centre and Network (CTCN), the Green Climate Fund (GCF), the work of the SBI on capacity-building and Article 6 of the Convention, the Standing Committee on Finance (SCF) and the Technology Executive Committee (TEC);

(c) Reports of United Nations agencies and other organizations: the secretariat of the Convention on Biological Diversity (CBD), the Food and Agriculture Organization of the United Nations (FAO), the Global Environment Facility (GEF), the International Energy Agency (IEA), the United Nations Convention to Combat Desertification (UNCCD), the United Nations Environment Programme (UNEP), the World Health Organization (WHO), WMO and the World Bank;

(d) Reports of regional organizations, including: the Arctic Monitoring and Assessment Programme (AMAP), the Caribbean Community Climate Change Centre (CCCCC), CGIAR, HCCPR and the Secretariat of the Pacific Regional Environment Programme (SPREP).

9. Fifty-three experts made a total of 60 presentations, with more experts presenting on theme 2 than on theme 1. Twenty additional experts attended the sessions and participated in the discussions. Bearing in mind that the AR5 is the most comprehensive and robust assessment of climate change to date,[7] a majority of the experts invited were from the IPCC (30 experts). The work of the SED was also supported by experts from the Adaptation Committee, the CBD secretariat, CCCCC, CGIAR, the CTCN, the GCF, the GEF, IEA, the SCF, SPREP, the TEC, UNCCD, WHO, WMO and the World Bank (see annex VI). When inviting experts, the geographical, cultural and gender balance was taken into consideration.

10. A moderated discussion guided by 90 questions (see annex V) followed the presentations. Parties asked approximately 260 questions (with slightly more questions focusing on theme 2 than on theme 1) and received over 330 answers, with more than one expert answering each question, on average. Additionally, experts presenting in one part of the session also attended other parts, allowing for linkages to be made among the topics addressed. Some of the IPCC experts were present at all sessions of the SED, thereby ensuring the scientific integrity of the information discussed.

11. A summary report on each SED session was made available on the 2013–2015 review web page[8] (see annexes I–IV).

III. Technical summary – dialogue

12. The SED considered many findings and featured a great deal of discussion. This technical summary aims to document this very rich exchange by synthesizing the views of participating experts and Parties. In order to keep this summary succinct, we did not delve into details, which are available in the annexes, and synthesized the main points from the presentations and dialogue from the SED sessions.

13. This technical summary should be read with a number of caveats. It is not meant to present an exhaustive assessment of the issues at hand, as it is confined to documenting the

---

[7] Decision 12/CP.20, paragraph 3.

[8] <http://unfccc.int/7521.php>.

dialogue held. Furthermore, the views expressed by experts during the dialogue and captured here should not be seen as taking precedence over the findings of the AR5 or the reports from other organizations considered in SED sessions. We, the co-facilitators, made every effort to ensure that this technical summary is factual and reflects the scientific understanding of the issues addressed.

14. This section opens with a summary of the overarching considerations regarding the long-term global goal. It then addresses the following: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention (theme 1 of the 2013–2015 review); the overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention (theme 2); and issues relating to a consideration of strengthening the long-term global goal, referencing various matters presented by the science, including in relation to a temperature rise of 1.5 °C.

A. Overarching considerations regarding the long-term global goal

15. Among the elements of the long-term global goal,[9] the SED addressed "reducing global greenhouse gas emissions" and "the increase in global average temperature below 2 °C above pre-industrial levels" (hereafter referred to as the limit for global warming), as well as the relationship between these elements. We first summarize the deliberations on the internationally agreed limit for global warming, and then those on the corresponding reduction in global greenhouse gas (GHG) emissions, given that this limit leads to an estimation of the budget of total cumulative anthropogenic carbon dioxide (CO_2) emissions and of the corresponding range of CO_2 equivalent (CO_2 eq) concentration levels in the atmosphere.[10] This in turns makes an estimation of the necessary reduction in global annual GHG emissions by mid-century possible (see paras. 21 and 22 below).

16. On the **global average temperature**, the IPCC reported an increase of 0.85 °C since 1880, a good approximation for pre-industrial levels (figure 2),[11] and WMO reported that 14 of the last 15 years were the warmest on record, with 2014 being the hottest.[12] More than 90 per cent of the energy accumulated in the climate system between 1971 and 2010 has been absorbed by the oceans, leading to their warming.[13] In terms of projections, for all representative concentration pathway (RCP) scenarios[14] of the IPCC, the global average temperature change is likely[15] to exceed 1.5 °C by 2100 relative to pre-industrial levels except for scenario RCP2.6.[16] For RCP4.5, warming is more likely than not to exceed 2 °C and will continue beyond 2100. The other RCP scenarios, which are closer to a 'business as usual' development, share these characteristics except that they are likely to exceed a

---

[9] See paragraphs 102–105 below on considerations relating to "taking action... on the basis of equity".

[10] See annex III, paragraphs 128–132, and figure 41 (note the probabilistic interpretation of scenarios that shows the relationship between atmospheric concentrations of CO_2 eq in 2100 and the probability of staying under 2 °C).

[11] See annex II, paragraph 18.

[12] El Niño played no part in the warming in 2014 (annex IV, paragraph 332, and figure 105). See also *WMO Statement on the Status of the Global Climate in 2014* (World Meteorological Organization. Available at <https://www.wmo.int/media/sites/default/files/1152_en.pdf>).

[13] See annex II, paragraph 19.

[14] Scenarios considered by the IPCC for projecting future climate conditions (see the summary for policymakers in the contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, box SPM.1. Available at <http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf>).

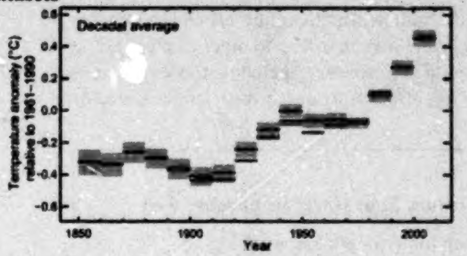
[15] For a definition of the uncertainty qualifiers used in this report, see footnote 1 to the summary for policymakers in the Synthesis Report of the AR5.

[16] See annex II, figure 15.

warming of 2 °C by 2100. Additionally, the IPCC reported that temperature changes will exhibit both inter-annual and decadal variability and regional differences (see, e.g., figure 3).[17] For example, regarding temperature extremes, heatwaves are expected to occur with higher frequency and duration.[18]

Figure 2

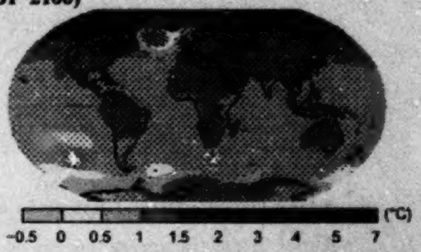
Observed global mean of combined land and ocean surface temperatures from 1850 to 2012, from three datasets



Source: Summary for policymakers in the contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.1(a).

Figure 3

Map of projected change in average surface temperature for RCP2.6 (1986–2005 to 2081–2100)



Source: Summary for policymakers in the contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.8.

Note: This map shows that even for a scenario with high mitigation action, future temperature changes vary among regions.

Abbreviation: RCP = representative concentration pathway.

17. The IPCC indicated that if a temperature limit were exceeded, which is sometimes referred to as an overshoot, warming could be returned to that limit in the longer term if the CO_2 content of the atmosphere is later actively reduced.[19] As for long-term aspects, an actual equilibrium in terms of temperature, notably of ocean waters, and sea level would only be reached after several centuries to millennia.[20] To a large extent, anthropogenic climate change, including ocean acidification and many impacts, are irreversible on at least a multi-century to millennial timescale.

18. **Parties sought clarification** on, inter alia: the reliability of short-term temperature projections, considering the reduced rate of warming over the last 15 years; uncertainties about the warmest year on record; committed temperature rise; the relationship between the timescale and physical changes in the climate system; and the limitations of working only with a temperature limit.

19. Experts explained that on a short timescale it remains difficult to predict when below or above average future warming would occur[21] and underscored the importance of using long-term temperature trends based on several decades (see also the trends of decadal averages in figure 2) instead of using only a few years when analysing the past.[22] They clarified that there is little warming commitment from past emissions in the physical climate system and that the future emissions determine future warming.[23] Despite the fact that any realized warming is basically irreversible, cutting emissions now has a swift effect

---

[17] See annex II, paragraph 33.

[18] See annex II, paragraph 34.

[19] CO_2 eq concentration overshooting the long-term stabilization level is typical for the scenarios limiting warming to 1.5 °C by the end of the century (see annex II, para. 60, and annex III, para. 132).

[20] See annex III, paragraph 59.

[21] See annex II, paragraph 24.

[22] See annex IV, paragraph 332.

[23] See annex II, paragraph 69.

by slowing down further warming within a few years. Moreover, actively removing CO_2 from the atmosphere, for example by using bioenergy with carbon capture and storage (BECCS),[24] results in cooling. They explained, however, that the timescale of physical changes depends on the type of changes (e.g. warming will immediately impact precipitation or extreme weather, whereas changes in the Greenland ice sheet melting or sea level rise would take much longer to occur). With respect to overshooting, the timescales for which the carbon budget for the long-term global goal is exceeded are similar to the timescales for which temperature exceeds the goal.[25]

20. Experts indicated that a temperature-only limit will not capture all changes in the climate system that follow from GHGs emissions and may thus lead to other changes being overlooked. This is because large-scale climate system responses, including those related to ocean acidification[26] and sea level rise,[27] may be affected by more than temperature, or show delayed responses to temperature.

Message 1

A long-term global goal defined by a temperature limit serves its purpose well

Parties to the Convention agreed on an upper limit for global warming of 2 °C, and science has provided a wealth of information to support the use of that goal. Despite the irreversibility of global warming, cutting carbon dioxide (CO_2) emissions now affects future warming within a few years. Removing CO_2 from the atmosphere results in cooling. Adding **other limits** to the long-term global goal, such as sea level rise or ocean acidification, **only reinforces the basic finding** emerging from the analysis of the temperature limit, namely **that we need to take urgent and strong action to reduce GHG emissions**. However, the limitations of working only with a temperature limit could be taken into account, for example, by aiming to limit global warming to **below 2 °C.**[a]

[a] See annex II, paragraph 47.

21. In terms of **reducing global GHG emissions** in order to limit global warming, the IPCC showed that the cumulative amount of total anthropogenic CO_2 the world can emit is limited. There is an approximately linear relationship between cumulative total anthropogenic CO_2 emissions and the global average temperature rise. Therefore, limiting global warming implies a maximum amount of cumulative CO_2 emissions. This means that **halting the global average temperature rise at any level will require net zero global CO_2 emissions** at some point in the future.[28] Furthermore, because of the cumulative budget constraint, higher global emissions in the near term would require lower global emissions in the long term, and, in case of overshooting, the use of CO_2 removal technologies.[29]

---

[24] See paragraph 56 below.

[25] If we overshoot emissions for 50 years we might stay above the target (concentration and temperature) for 50 years (see annex II, paras. 67 and 68).

[26] See annex IV, paragraph 249.

[27] Unlike global average warming, the rate of global mean sea level rise also depends on the pathway of CO_2 emissions, which means that reducing emissions earlier rather than later leads to a lower sea level rise (see annex II, paras. 26 and 38, and figure 16).

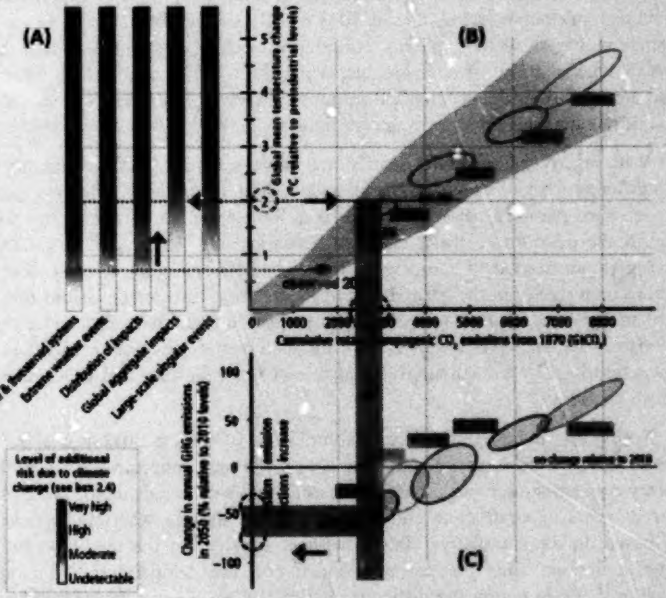
[28] See annex II, paragraphs 35, 59 and 60. For example, the upper amount is 1,000 Gt C for a probability greater than 66 per cent of staying under 2 °C. This amount is reduced to about 790 Gt C when accounting for non-CO_2 forcing as in scenario RCP2.6.

[29] See annex III, paragraphs 131 and 132, and figure 42.

22. Figure 4 illustrates that aggregated risks from climate change (panel A) depend on the level of global warming and cumulative CO_2 emissions (panel B), which in turn depend on global annual GHG emissions over the next decades (panel C). Limiting global warming to **below 2 °C in the long term implies** (follow red arrows) **a limit for cumulative CO_2 emissions**, which can be estimated from the corresponding category of least-cost mitigation pathway scenarios (panel B, 430–480 ellipse). This limit also implies, **in the near term, a constraint for changes in annual GHG emissions by 2050** relative to 2010 (panel C, 430–480 ellipse).[30] The figure also shows that, at 2 °C of warming, aggregated risks of climate change for unique and threatened systems from extreme weather events and from distribution of impacts will become high (panels A and B, upper dotted horizontal line). Additionally, such risks from global aggregated impacts and large-scale singular events will become moderate compared with their current levels (panels A and B, lower dotted horizontal line).

Figure 4

The relationship between global average temperature change, risks from climate change, cumulative anthropogenic carbon dioxide emissions and changes in global annual greenhouse gas emissions by 2050 relative to 2010 for 2 °C of warming above pre-industrial levels



Source: Adapted from the summary for policymakers in the Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.10.

Note: Limiting aggregated risks from climate change (panel A) by a global average temperature limit of 2 °C (blue/red circle in panel B) implies, through the limited carbon budget (red circle at bottom of panel B), a reduction in annual GHG emissions of 40–70 per cent relative to 2010 emissions by 2050 (red circles in panel C).

Abbreviation: GHG = greenhouse gas.

23. In terms of **GHG emission pathways**, a scenario analysis shows that the 2 °C limit requires a large global emission reduction in the short to medium term, and near-zero or negative global emissions in the second half of the twenty-first century (40–70 per cent

---

[30] See annex IV, paragraphs 35–37 and 61–63; and figures 57, 58, 68 and 69.

reduction in GHGs globally from 2010 levels by 2050 and near- or below-zero global GHG emission levels in 2100 in order to likely limit global warming to below 2 °C).[31] According to UNEP, to stay within the 2 °C warming limit, global CO_2 emissions need to decrease to net zero between 2055 and 2070, and all GHGs emissions need to decrease to net zero between 2080 and 2100. The longer we wait to bend the curve of currently increasing global emissions of GHGs, the steeper we will have to bend it down later, even with negative emissions towards the end of the century.[32] Even a 3 °C limit requires a substantial reduction in global GHG emissions, a fundamental transformation of the energy system and global GHG emission levels towards zero by 2100.[33]

24. **Parties sought clarification** on, inter alia: uncertainties associated with the cumulative CO_2 budget, the corresponding global emission reductions for remaining under 2 °C of warming, and the implication for the policymaking process of a wide range of estimates being provided;[34] the importance of global emission pathways; current anthropogenic concentration of CO_2 eq and the number of years we can still emit at current rates while limiting warming below 2 °C or 1.5 °C; pathways for global non-CO_2 emissions; and the relationship between emissions and the capacity of land and ocean sinks.

25. Regarding uncertainties and the ranges of estimates provided, experts clarified that the findings of the Working Group III (WGIII) of the IPCC refer to cost-effective mitigation scenarios while explicitly considering societal uncertainties, such as delaying actions or unavailability of technologies, while the findings of Working Group I (WGI) include uncertainty in the geophysical response. Experts emphasized repeatedly that in the context of risk management, larger uncertainties will mean a lower carbon budget.[35]

26. With regard to global GHG emission pathways, experts underscored that they could lead to different rates of change in the climate system, resulting in different types and rates of impacts (see para. 27 below), and that therefore global emissions must peak and then decline in the near future for a range of scenarios and warming limits. **CO_2 removal technologies** are needed to compensate for past GHG emissions overshooting the target and, more importantly in the second half of the century, also for emissions that cannot be reduced to zero (e.g. non-CO_2 emissions from agriculture). Although reducing non-CO_2 emissions can be an important element of mitigation strategies, the temperature change is mainly determined by the cumulative budget of CO_2 emissions, and CO_2 emissions drive long-term warming.[36]

27. Noting that the atmospheric concentration of CO_2 eq in 2011 was about 430 ppm, experts stressed the difficulty of achieving a 430–480 ppm concentration in 2100 without a temporary concentration overshoot. They warned that simple calculations of the remaining number of years of emitting at current levels while limiting warming to below 2 °C or 1.5 °C based on the cumulative budget, without considering the possibility of achieving negative emissions, may make achievement of the temperature limit appear too challenging.[37] While noting the difficulty of quantifying changes in land and ocean sinks for high-emission scenarios, experts stressed that the direction is clear: the higher the emissions, the more the capacity of sinks will be weakened.

---

[31] See annex III, paragraph 131.

[32] See annex IV, paragraph 115, and figure 78.

[33] See annex III, paragraphs 112 and 132.

[34] Working Group I indicated a 14–96 per cent reduction below 1990 levels in 2050, while Working Group III indicated a 40–70 per cent reduction below 2010 levels in 2050.

[35] See annex II, paragraph 64, annex IV, paragraph 88, and figure 14. See also the pink plume and the ellipsis in figure 4.

[36] See annex III, paragraph 166, and annex IV, paragraph 84.

[37] See annex IV, paragraph 92.

Message 2

Imperatives of achieving the long-term global goal are explicitly articulated and at our disposal, and demonstrate the cumulative nature of the challenge and the need to act soon and decisively

Scenario analysis shows that limiting global warming to below 2 °C implies the following: a large reduction in global greenhouse gas emissions in the short to medium term, global carbon dioxide neutrality early in the second half of this century, and negative global greenhouse gas emissions towards the end of the twenty-first century.[a] The longer we wait to bend the currently increasing curve of global emissions downward, the steeper we will have to bend it, even with negative emissions. **Limiting global warming to below 2 °C necessitates a radical transition** (deep decarbonization now and going forward), **not merely a fine tuning of current trends.**

[a] See annex II, paragraph 23.

B. Theme 1 of the review – the adequacy of the long-term global goal in the light of the ultimate objective of the Convention

28. The adequacy of the long-term global goal can be assessed by examining the level of risk of climate impacts for any given level of global warming and determining whether these risks are unacceptably high and should therefore be decreased. To this end, the SED considered the adequacy of the goal in the following terms: current risks and observed impacts of climate change, future risks and impacts at 2° C warming, and future risks and impacts avoided in relation to a 'business as usual' scenario.[38] Furthermore, the SED also considered the feasibility of limiting global warming to below 2 °C within a global risk management framework that respects planetary boundaries.

1. Risk framing of climate impacts

29. The AR5 framed impacts of climate change in terms of risks (figure 5) and assessed hundreds of emerging and key risks at the global, regional and sectoral levels. Each risk was assessed for the present, the near term and for levels of warming of 2 °C and 4 °C above pre-industrial levels, including variants for reducing risks with adaptation at "current" and "high" levels (figure 6). Risk levels often increase with temperature and are sometimes linked to the rate of warming as well as to magnitudes of sea level rise and ocean acidification.

30. In figure 6, the benefits of mitigation are shown by the difference in the level of risk for 2 °C and 4 °C of warming (the grey area of each bar represents an assessed risk). Near-term (2030–2040) risks are similar for all RCP scenarios because in the near term warming does not vary significantly, with atmospheric GHG concentrations remaining at first similar. Therefore, adaptation provides the main opportunities to control risks for this period. However, mitigation investments made in the immediate future play an essential role in addressing climate change throughout this century and in the long term in general.[39]

31. Sectoral risks at the global scale and some 80 regional risks were condensed into eight key risks, such as risks of death, injury or disrupted livelihoods. Key risks include severe ill health and disrupted livelihoods for large populations due to inland flooding in some regions, such as low-lying coastal zones, and systemic risks due to extreme weather

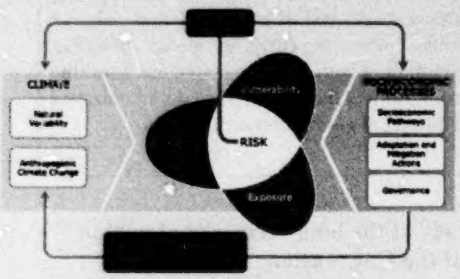
---

[38] With a focus on enabling ecosystems to adapt naturally to climate change, ensuring that food security is not threatened, and enabling economic development to proceed in a sustainable manner.

[39] See annex III, paragraph 18.

events leading to a disruption or breakdown of infrastructure networks and critical services. These key risks have been further aggregated and translated into five reasons for concern (RFC), which illustrate the implications of warming and of adaptation limits for people, economies and ecosystems across sectors and regions (figure 4, panel A).[40]

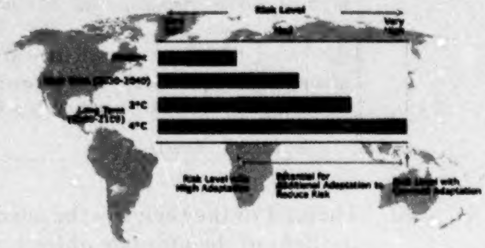
Figure 5
Illustration of the core concept of climate risks



Source: Summary for policymakers in the contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.1.

Note: To some extent climate risks can be managed, since they result from the interaction of climatic hazards, vulnerability and exposure.

Figure 6
Assessing climate risk by considering 102 global, regional and sectoral key risks



Source: Slide 13 of the presentation by Mr. Chris Field (Intergovernmental Panel on Climate Change) at the third session of the SED, available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/0_field_sedpart1.pdf>.

Note: Benefits of mitigation are shown by the risk reduction from the forth (4 °C) to the third (2 °C) risk bar. The benefits of adaptation are shown by the risk reduction represented by the grey parts of the risk bars (blue = 'high' adaptation levels, blue plus grey = 'current' adaptation levels). No particular risk is shown in this schematic figure; see figure 7 for examples of actual risks.

32. The risks assessed illustrate how complex and different regional vulnerabilities are (figure 7). Examples of such risks are: food insecurity and malnutrition (high and very high risks in Africa, Asia, and Central and South Asia in relation to a global temperature increase of 4 °C); floods (in all regions with most of the population affected in East, South-East and South Asia owing to an increase in exposure and vulnerability, including costal floods and inundation in low-lying coastal areas such as in Small islands, Asia, Australasia and North America); extreme heat and heatwaves (e.g. in Europe, Asia and Australia); ecosystems without adaptation potential (high and very high risks, already in the near term, in polar regions and oceans (e.g. corals), the latter also for a warming of 2 °C); drought, water shortages (in all regions, in particular if already dry now); and increased damage from wildfires (e.g. North America, Europe and others).[41]

33. **Parties sought clarification** on, inter alia: the qualification of risks, including why some risks have been deemed high and how local risks have been used to determine regional or global risks; the level of warming at which rapid change in risk level may take place; comparability of risks and how risks could be weighted; how 'high' adaptation is defined and if it includes forced relocation; and if adaptation was considered in determining the climate risks associated with the RFC.

34. Experts indicated that they used coordinated expert judgment based on a set of explicit criteria to qualify the level of risk and the possibility for adaptation. Noting that aggregation into key risks may mask local high risks, they clarified that information on

---

[40] See annex III, paragraphs 30–33.

[41] See annex III, paragraph 40.

such risks is available in the underlying report[42] and underscored the importance of the regional risk assessments.[43] They explained that: the AR5 identified hot spots[44] that could be the focus of specific policies; the rate of change that is tolerable is preferable to a guardrail threshold, for example owing to non-linear responses of organisms to climate stressors; and considering the ways in which risks interact is key.[45] The risk concept is robust and enables better comparability, but limitations still exists, for example because of the different causes of risks or of methodologies used in studies. Autonomous adaptation, as well as limits to adaptation, have been taken into account for the RFC for unique and threatened systems, distribution of impacts and large-scale singular events, independently of the development pathway.[46]

35. Adaptation can be restricted by a range of factors, such as those related to geography, high-emission pathways or socioeconomic constraints in adaptive capacity.[47] On the concept of 'high' adaptation, participants in the discussions pointed out that forced relocation is hardly an option for small island developing States, as it implies fundamental changes in livelihoods and cultural values. Experts clarified that they considered the most probable development pathways for each region and that the definition of a highly adaptive state was left to the writing team to assess taking into account the cultural environment and other limits that may persist, in particular economic ones, as long as adaptation is not seen as a cost-effective investment. Furthermore, constraints to 'high' adaptation are context-sensitive and reflect the fact that adaptation is in general difficult to assess, particularly for long-term time frames, beyond mid-century.[48]

Message 3

Assessing the adequacy of the long-term global goal implies risk assessments and value judgments not only at the global level, but also at the regional and local levels

The global climate determines regionally experienced risks. While global assessments of climate risks inform global policy choices and global risk management, they should be complemented by regional and local perspectives. A key element of these perspectives is the value judgment of when the scale (e.g. frequency and severity) of climate impacts results in a transition from 'acceptable' to 'unacceptable'.[a] This leads to a greater appreciation of the role played by all decision makers, including subnational authorities and cities.

[a] See annex III, paragraphs 20, 23, 54 and 97.

2. Current risks and observed impacts of climate change

36. According to the AR5, the observed impacts of climate change **at 0.85 °C of warming** are consequential and wide-ranging, spanning all regions and sectors.[49] Impacts have been observed on: food production, including constraints on the increase in wheat and maize yields, and negative impacts on marine fisheries; sea level rise and its associated impacts on low-lying coastal zones including small islands; glaciers and ice sheets, including consistent mass loss, and Arctic systems; ecosystems, including increased tree mortality, resulting in some cases in forest dieback, as well as negative impacts on Arctic,

---

[42] See annex III, paragraph 64.
[43] See annex III, paragraph 57.
[44] Areas where risk is very high or where risk levels could change significantly.
[45] See annex III, paragraph 65.
[46] See annex IV, paragraph 96.
[47] See annex III, paragraph 39.
[48] See annex III, paragraph 58.
[49] This refers to impacts due to climate change irrespective of its causes.

freshwater and terrestrial species and warm water coral reefs; and sustainable economic development, including impacts on livelihoods and increased economic losses from extreme weather.[50] Furthermore, key current climate risks are already high in some regions (figure 7).

37. The regional chapters of the contribution of IPCC Working Group II (WGII) to the AR5 and presentations of observed impacts in the Caribbean, the Pacific and the Arctic regions, as well as on agriculture, illustrated how these impacts vary across regions and populations.[51] Some regions have a substantial economic dependence on climate-sensitive sectors, such as ecosystem services and tourism, with limited opportunities for economic diversification. Adaptation potential is limited for many of the observed impacts of climate change, and implementation of adaptation options, if available, comes at very high cost in relation to countries' national budgets.

38. Climate-related hazards exacerbate other stressors, such as socioeconomic and environmental stressors, and have a negative impact on people and livelihoods, with the emergence of critical thresholds when all stressors converge. As warming continues, climatic stressors will play an increasingly important role, largely determined by the emission pathway chosen.[52] While more and more impacts are attributable to climate change, the attribution is sometimes difficult owing to non-climatic stressors and the influence of other convoluting factors further down the chain of impacts.[53]

39. Deliberations revealed that the current level of warming is causing certain impacts that are beyond the current adaptive capacity of many people.[54] **Parties sought clarification** regarding: the discrepancy between the qualification of risk to unique and threatened systems as 'moderate' at current warming (owing to unevenly distributed impacts) and the fact that they are high in many areas; and the safe levels of impacts at which the objective of the Convention can still be achieved.

40. Experts explained that the aggregation of risks is masking regional differences, that the level of risk is related to the number of causal links[55] that the IPCC was able to assess in developing the RFC, and there are limits to characterizing every possible combination of risks that have potential impacts. On the qualification of 'safe' or 'dangerous' levels of impacts, experts noted that this depends on the scale, frequency and severity of the impact, and implies a value judgment. From the perspective of a species, an individual or a village that is already facing severe impacts, the current level of warming can already be unsafe.

---

[50] See annex III, paragraphs 17 and 35–37; and figures 21 and 24.

[51] See annex IV, paragraphs 258–265 and 271–291.

[52] See annex III, paragraph 29.

[53] Non-climatic factors are currently the dominant drivers of observed changes in terrestrial ecosystems, with the exception of highly temperature-sensitive systems, such as the polar regions, high mountains and the tropics (annex III, paras. 34, 35 and 37; annex IV, para. 89; and figures 21 and 24).

[54] See annex III, paragraphs 54 and 97.

[55] See annex III, paragraph 79.

Message 4

Climate change impacts are hitting home

Significant climate impacts are already occurring at the current level of global warming and additional magnitudes of warming will only increase the risk of severe, pervasive and irreversible impacts. Therefore, **the 'guardrail' concept, which implies a warming limit that guarantees full protection from dangerous anthropogenic interference, no longer works.**[a] This calls for a consideration of societally[b] or otherwise acceptable risks of climate impacts.

[a] See annex III, paragraphs 54 and 97.

[b] See annex III, paragraph 54, and annex IV, paragraph 163.

3. Future risks and impacts of climate change for a 2° C rise in global average temperature and avoided impacts of climate change in relation to a 'business as usual' scenario

41. On future risks and impacts of climate change, experts warned that the increasing magnitude of warming will only increase severe, pervasive and irreversible impacts.[56] They also indicated that for any level of global warming, regional differences in impacts are projected to become more pronounced.

42. In **a world 2 °C warmer** than in pre-industrial times, the rate of climate change would become too rapid for some species to move sufficiently fast and migrate to their preferred temperature zones;[57] long-term sea level rise may exceed 1 m; Arctic summer sea ice will be further significantly reduced; some unique systems would be at high risk; the risks of combined ocean warming and acidification would become high, and, for some phenomena such as mass coral bleaching, very high; and crop production would be at high risk with some potential for adaptation.[58] Many more moderate and high risks would emerge: indigenous people would be at risk of loss of land and cultural and natural heritage, and cultural practices embedded in livelihoods would be disrupted. The IPCC expert named as damage the residual risk that remains with a 2 °C temperature rise accompanied by 'high' adaptation.[59] Furthermore:[60]

(a) Unique and threatened systems would be at high risk, in particular systems with limited or barely any adaptive capacity (e.g. Arctic sea ice and coral reefs);[61]

(b) Extreme weather events would pose a high risk for human health, urban housing and infrastructure in megacities, also in relation to the urban heat island effect, air pollution and differential vulnerabilities; displacement and permanent migration; livelihood struggles and conflict in resource-dependent livelihoods, such as agriculture and pastoralism; and high impacts on livelihood (trapped populations are more vulnerable to environmental change because of their inability to move);[62]

---

[56] See annex I, paragraph 19, and annex III, paragraphs 18 and 33.

[57] See annex III, paragraph 19; and annex IV, paragraph 43.

[58] See annex IV, paragraph 43

[59] See annex III, paragraph 26.

[60] See also the AR5 Synthesis Report, box 2.4, on reasons for concern regarding climate change.

[61] See annex IV, paragraphs 43, 78 and 244; see also the AR5 Synthesis Report, box 2.4.

[62] See annex III, paragraphs 73 and 105, and annex IV, paragraph 49.

(c) The risks will be increasingly unevenly distributed, and are generally greater for disadvantaged people and communities in countries at all levels of development; populations that experience shifts from transient to chronic poverty and related social marginalization and food insecurity; and the elderly, children, the socially marginalized, and outdoor workers, who are disproportionally at risk from heat stress;[63]

(d) Global aggregate impacts show a moderate economic impact, but these aggregates may mask impacts across sectors and regions (evaluations are incomplete, in part because they do not take into account large-scale singular events affecting several sectors at once or other effects from disrupted interdependencies);[64]

(e) The risk of large-scale singular events, such as the disintegration of ice sheets in Greenland and Antarctica, would be moderate.[65]

43. In a **world 4 °C warmer, many global risks are high and very high.**[66] Most projected ecosystem impacts would occur at high risk levels. Climate change velocity would be much too high for terrestrial and freshwater species to move sufficiently fast. Biodiversity losses would take place, including substantial species extinction and disruption of ecosystem services. The risks of combined ocean warming and acidification would become very high. The catch potential of fisheries would be greatly reduced, and crop production would be at very high risk with no potential for adaptation. The long-term sea level rise would far exceed 1 m, and Arctic summer sea ice would be lost. Some unique systems would be threatened, and the risks from extreme weather events would become very high, or medium to high with adaptation. These risks would put people who are socially, economically, culturally, politically, institutionally or otherwise marginalized at most risk.

44. During one discussion, a World Bank expert underlined the non-linearity of projected risks and impacts as we move from 2 to 4 °C of warming, in particular in relation to water availability, heat extremes or the bleaching of coral reefs, with close to double impacts in a world 4 °C warmer compared with one 2 °C warmer than in pre-industrial times, implying very different adaptation needs.[67] A WHO expert stated that in a world 4 °C warmer, the health risks are very high in comparison with current levels.[68]

---

[63] See annex III, paragraphs 40 and 43, and annex IV, paragraphs 47 and 49.

[64] See annex III, paragraph 65, 74 and 103, and annex IV, paragraph 49.

[65] See annex II, paragraph 39, annex III, paragraph 153, and figure 4; see also the AR5 Synthesis Report, box 2.4.

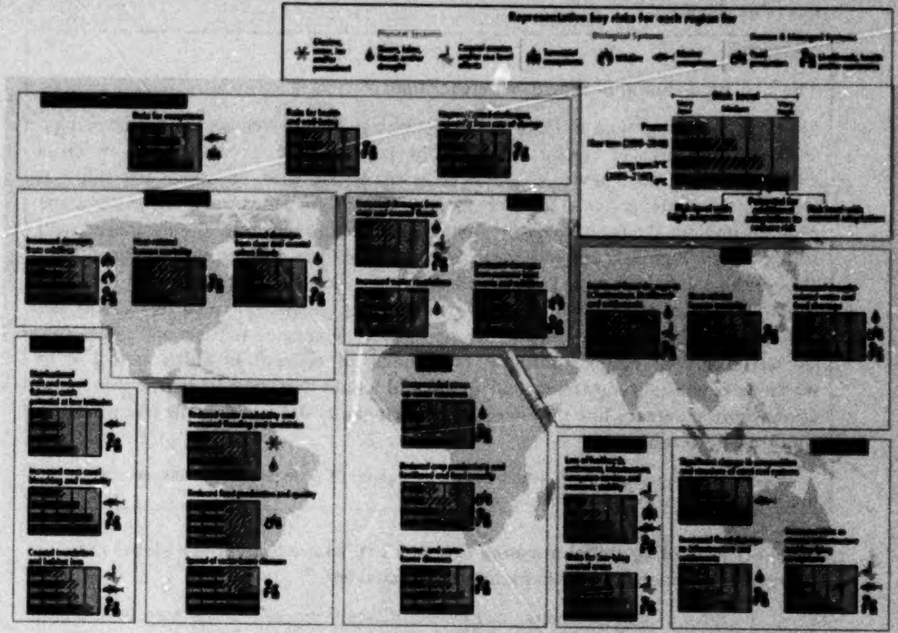
[66] See annex III, paragraphs 40, 42, 43, 63, and 69, annex IV, paragraphs 30, 33, 49, 244, 255, 275, 286 and 311, and figures 59 and 103; see also the AR5 Synthesis Report, box 2.4.

[67] See annex IV, paragraph 120, which indicates that water availability is projected to be reduced by 20 per cent at 2 °C of warming and by 50 per cent at 4 °C of warming.

[68] See annex IV, paragraph 143.

Figure 7

Representative key risks for each region, including the potential for risk reduction through adaptation and mitigation, as well as limits to adaptation



Source: Summary for policymakers in the Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.8.

Note: The figure shows representative key regional risks (see also figures 5, 6, and para. 32 of the document).

45. Significant opportunities for adaptation exist in a world 2 °C warmer, although under all of the assessed scenarios some residual risk from adverse impacts remains. There are limited prospects for risk reduction through adaptation in a world 4 °C warmer, and impacts would significantly increase in all regions.[69] With that amount of warming, limits to adaptation would be reached in relation to aspects such as urban water supply systems, heat-sensitive people, agricultural productivity and food security, means of implementation, and the preservation of cultural identity.[70] Moreover, the adaptation potential in case of conflict over land acquisition and displacement will decline significantly, risks of food insecurity (Africa and Asia) and malnutrition (Africa and Central and South Asia) will be high and very high,[71] and flooding risks will become more widespread in Asia and in Central, South and North America.[72]

46. Parties sought clarification on risk related to urban–rural interaction and on impacts of climate change on poverty reduction. Experts clarified that the urbanization process taking place in developing countries will exacerbate risks such as high mortality, injuries or loss of infrastructure mainly owing to the high population density resulting from

---

[69] See annex III, paragraphs 39 and 43.

[70] See annex IV, paragraph 50.

[71] See annex III, paragraph 40.

[72] See annex III, paragraph 42.

urbanization and gaps in infrastructure.[73] On the impacts of climate change on poverty reduction, they indicated that climate change in a world 2 °C warmer is already expected to slow down economic growth and hinder poverty reduction efforts, in particular in vulnerable countries.[74]

Message 5

The 2 °C limit should be seen as a defence line

Limiting global warming to below 2 °C would significantly reduce the projected high and very high risks of climate impacts corresponding to 4 °C of warming, which is where we are headed under a 'business as usual' scenario. It would also allow a significantly greater potential for adaptation to reduce risks. However, many systems and people with limited adaptive capacity,[a] notably the poor or otherwise disadvantaged, will still be at very high risk, and some risks, such as those from extreme weather events, will also remain high. Adaptation could reduce some risks (e.g. risks to food production could be reduced to 'medium') but the risks to crop yields and water availability are unevenly distributed. Moreover, the risks of global aggregated impacts and large-scale singular events will become moderate. **The 'guardrail' concept, in which up to 2 °C of warming is considered safe, is inadequate and would therefore be better seen as an upper limit, a defence line that needs to be stringently defended, while less warming would be preferable.**

[a] See annex III, paragraph 39, which cites the example of systems such as the cryosphere, the Arctic, high mountains and coral reefs.

4. Feasibility of limiting global warming to below 2 °C in the context of a global risk management framework within planetary boundaries

47. The risks of climate change can be significantly reduced if warming is limited to below 2 °C, but that limit requires deep cuts in global GHG emissions. Such cuts imply the scaling-up of low-carbon technologies,[75] which poses substantial technological, economic and institutional challenges, in particular in the energy sector and potentially in land use. Mitigation action has co-benefits but also risks.[76]

48. The AR5 indicated that immediate mitigation, before 2030, would result in multiple cost-effective mitigation pathways for limiting warming to below 2 °C above pre-industrial levels (figure 8, left-hand side panel, dark green trajectories). This would be characterized by an annual rate of CO_2 emission reduction after 2030 of about 3 per cent (median value, middle panel) and would require a roughly a 90 per cent scaling-up of low-carbon energy technologies by 2050 compared with 2010 (right-hand side panel). Delaying mitigation (left-hand side panel, light green trajectories, "Cancun pledges") requires a more ambitious profile after 2030, characterized by an annual rate of CO_2 emission reduction of about 6 per cent (median value), which implies a dramatic tripling of low-carbon energy technologies, with related significant risks.

49. Available **estimates of mitigation costs** vary widely, but do not significantly affect global gross domestic product (GDP) growth. Uncertainties surrounding the global mitigation costs are due to varying model assumptions, which are partially due to the differences in estimates of the rates of low-carbon technology uptake. While global costs rise with the level of ambition of mitigation action, this action would marginally delay, but

---

[73] See annex III, paragraph 103.

[74] See annex IV, paragraph 81.

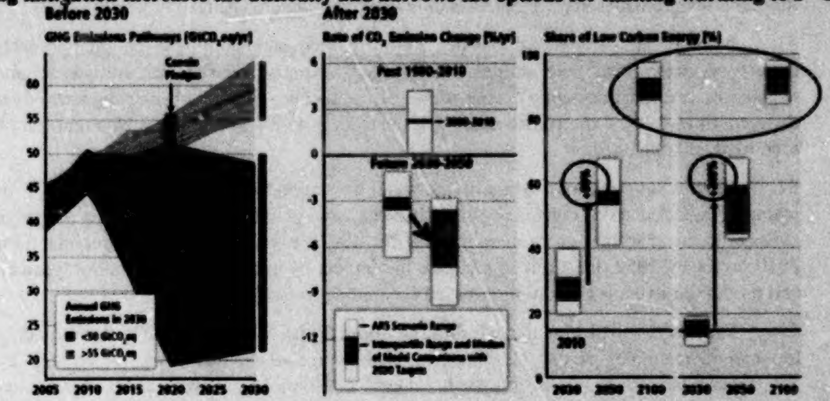
[75] Approximately by 300 per cent above current levels by 2050.

[76] See annex IV, paragraph 61.

not sacrifice, economic growth, which indicates that economic and emission growth can be decoupled.[77]

Figure 8

Delaying mitigation increases the difficulty and narrows the options for limiting warming to 2 °C



Source: Slide 13 of the presentation by Mr. Edenhofer (Intergovernmental Panel on Climate Change) at the 1st meeting of the fourth session of the Structured Expert Dialogue, available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141202_sed_edenhofer_lima_final4.pdf>.

Note: Emission pathways (left), annual emission reduction rates (middle) and share of low-carbon technologies (right) for a "soon and decisive mitigation action" (dark green) versus challenges and risks of delayed and more costly action (light green) (see para. 48 for details).

Abbreviations: AR5 = Intergovernmental Panel on Climate Change Fifth Assessment Report, CO_2 eq = carbon dioxide equivalent, GHG = greenhouse gas.

50. **The availability of technologies** seriously affects mitigation costs. Moreover, technological limitations or delaying the availability of technologies will increase the costs and reduce the feasibility of low-carbon scenarios. Without carbon dioxide capture and storage (CCS) and with limited availability of bioenergy, the mitigation costs would increase markedly in the medium term.[78]

51. The IEA presented some cost-effective short-term action that could stop the growth in emissions by 2020 at no net economic cost, reducing emissions by 3.1 Gt CO_2 eq and making 80 per cent of the savings required for a 2 °C pathway.[79] Mitigation scenarios indicate the need to **fully decarbonize energy systems**, but there is flexibility in that process, and carbon pricing allows all sectors of the economy to identify 'low-hanging fruit' in terms of mitigation.[80] The IPCC has stressed that a consistent carbon pricing, covering all sectors of the economy, is a defining feature of the 2 °C scenarios.[81]

52. Mitigation action comes with **co-benefits**, in particular for human health, biodiversity conservation and other societal goals, that are however challenging to define and quantify. The IEA emphasized that in many cases these non-climate drivers are the real

---

[77] See annex III, paragraph 115. According to the IEA, global emissions of CO_2 from the energy sector stalled in 2014, marking the first time in 40 years that a reduction in emissions was not tied to an economic downturn, <http://www.iea.org/newsroomandevents/news/2015/march/global-energy-related-emissions-of-carbon-dioxide-stalled-in-2014.html>.

[78] See annex III, paragraph 115.

[79] See annex IV, paragraph 132.

[80] See annex III, paragraphs 116 and 183, and annex IV, paragraph 133.

[81] See annex III, paragraphs 183, 184 and 187.

reasons that governments take action and should therefore be harnessed.[82] The IPCC found that there are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses.[83] However, some experts pointed out that mitigation action has not only co-benefits, but also risks,[84] although these risks are not of the same severe, widespread and irreversible nature as climate change risks.[85]

53. Noting that the optimal balance of mitigation, adaptation and residual impacts cannot be determined with current knowledge,[86] experts stressed that mitigation and adaptation are complementary approaches to reducing climate change impacts over different timescales. Experts also noted that the risks from mitigation and adaptation can be identified and managed.

54. **Parties sought clarification** on the window of opportunity for staying under 2 °C of warming and the risks created by overshooting, the practicality of achieving negative emissions, the marginal costs of mitigation for 40–70 per cent emission reduction from 2010 levels by 2050, the Cancun pledges, the impact of mitigation on economic growth, and production- versus consumption-based accounting for emissions.

55. Experts clarified that the **window of opportunity** is determined by how quickly low-carbon technologies can be scaled up and by the associated risks, rather than by atmospheric physics, which is only the boundary condition. Mitigation action over the next decade will determine the amount and cost of mitigation action required after 2030. Risk related to scaling up low-carbon technologies increases when mitigation is delayed, and overshooting is a typical feature of low-stabilization scenarios, which all have risks.

56. The **practicability of negative emissions** depends on costs, trade-offs and the feasibility of various scenarios. The IPCC presented options for generating large amounts of energy from BECCS and the associated risks for biodiversity and food security and prices, stressing that policymakers need to consider the trade-offs.[87] If CCS and therefore BECCS technologies are not available, for example because of the associated storage risks, the land use and forestry sector must contribute significantly to the mitigation effort. To reduce the associated risks, BECCS should be accompanied by an integrative institutional framework that takes into account the competition for land, notably a carbon-pricing mechanism that covers all sectors, including land use.[88]

57. On **marginal mitigation costs**, experts underscored that the decision on reducing global GHG emissions by 40–70 per cent from 2010 levels by 2050 is not only a matter of cost, because mitigation action by 2050 will also influence the amount of negative emissions needed in the second half of the century.[89] Experts also stated that the **Cancun pledges are more consistent with a 3 °C** than a 2 °C temperature increase by 2100.[90] They also underscored that the impact of the Cancun pledges could differ substantially depending on their interpretation.[91]

---

[82] See annex III, paragraph 148, and annex IV, paragraph 136.

[83] See annex III, paragraph 116, and annex IV, paragraphs 75, 119, 147, 155, 171, 177, 180, 208, 243 and 298.

[84] See annex III, paragraphs 83, 84, 98 and 177, and annex IV, paragraphs 61, 75 and 243.

[85] See annex IV, paragraph 61.

[86] See annex III, paragraph 81, and annex IV, paragraph 58.

[87] See annex IV, paragraphs 75 and 243, and figure 90.

[88] See annex III, paragraphs 120, 157; and annex IV, paragraph 93.

[89] See annex III, paragraph 158.

[90] See annex III, paragraphs 113, 133, 145 and 191.

[91] See annex III, paragraph 160; and figure 6.

58. On **impact of mitigation on economic growth**, experts clarified that although climate mitigation can be seen as an opportunity cost (as it will reduce future consumption) it will also provide opportunities for new investments.[92] They noted that in an ideal world, the method used to account for emissions (production- versus consumption-based) would not change the results.[93]

Message 6

Limiting global warming to below 2 °C is still feasible and will bring about many co-benefits, but poses substantial technological, economic and institutional challenges

The costs are manageable, even without taking into account the co-benefits of mitigation, and various policy options could be deployed to manage the risks of the necessary mitigation action.

The feasibility of the long-term global goal could be assessed in an emerging, iterative, global risk management framework that has multiple feedbacks from different sources and takes into account planetary boundaries. To this end, periodic reviews would provide an opportunity to assess and reassess the overall progress towards reducing risks of climate impacts and progress of mitigation and adaptation action, thereby contributing to a science-based risk management of the pathways to a low-carbon and climate-resilient future.

C. Theme 2 of the review – overall progress made towards achieving the long-term global goal, including a consideration of the implementation of the commitments under the Convention

59. The SED considered current and possible future overall progress towards the long-term global goal. To this end it addressed issues related to measuring the overall progress made towards the long-term global goal, including its effect on the global average temperature. In this context, the SED also looked into the latest insights and updates from the IPCC and science in general, processes under the Convention, and other organizations, including the World Bank, IEA, WMO and UNEP, as well as progress made on finance, capacity-building and technology.

1. Measuring progress

60. The IPCC continued to use the global warming potential as the metric for comparing and aggregating global anthropogenic GHG emissions for various gases. Trends in stocks and flows of global GHG emissions were estimated with associated uncertainties. In terms of global GHG pathways, the IPCC indicated where science tells us we should be in 2050 to limit global warming below 2 °C (see paras. 21–23 above). The IPCC estimated current global warming and projected temperature changes for all RCP scenarios, as well as for all categories of most cost-effective mitigation scenarios (see paras. 15–18 above) and the associated probabilities of limiting global warming below 2 °C.

61. In terms of adaptation, the IPCC used qualitative metrics to describe observed climate impacts[94] and future risks of climate impacts.[95] For future risks, progress could be

---

[92] See annex III, paragraph 123.

[93] See annex III, paragraph 192.

[94] Ranges of confidence in attribution of impacts to climate change and type of contribution of climate change to impacts (minor or major contribution).

[95] See paragraphs 29–35 above.

measured by their reduction through adaptation and mitigation. The RFC have been used to ascribe the increase in globally aggregated risks of climate impacts to global warming. Possible progress in avoiding risks at the global scale could also be measured in terms of the difference between the levels of risk for each of the five RFC at current and future levels of warming.

62. UNEP presented an assessment of overall progress on mitigation and adaptation through the *Emissions Gap Report*[96] and the *Adaptation Gap Report*,[97] respectively. UNEP explained that the *Emissions Gap Report* assesses emission trends, where these trends seem to be taking us, where the full implementation of the Cancun pledges would take us, and where we need to be to stay below the 2 °C warming limit with some given probability.[98] Estimating the global adaptation gap is far more challenging than calculating the global emissions gap because of the lack of a globally agreed goal or metrics for adaptation, and because adaptation is a response to specific risks of climate impacts that are local in nature and vary over time.[99]

63. **Parties sought clarification** on the appropriate metrics for comparing all the consequences of the different global emission pathways for support of the 2013–2015 review, including the possibility of assessing step-wise progress towards the long-term global goal in terms of partial limits for temperature rise for pre-defined periods of time (e.g. a series of decades) throughout this century.

64. On assessing stepwise progress towards the long-term global goal by using partial limits for temperature rise, the IPCC explained that such an approach would be difficult owing to the high variability of temperatures, which is also responsible for the difficulty of predicting decadal temperatures. Some periods experience less warming, and these short-term trends could lead to incorrect conclusions, which would then be very challenging to correct. Instead, the IPCC suggested that the goal be revised based on past and future committed emissions, which are well documented and can be clearly translated into long-term warming trends. The IPCC also indicated that the relative uncertainty ranges are wider when using the global temperature potential compared to the global warming potential currently in use for comparing CO_2 with other greenhouse gases.[100] On the appropriate metrics for comparing all the consequences of different emission pathways in order to support the review of the adequacy of the long-term global goal, the IPCC indicated that several other metrics exist and that no single metric can accurately compare all the consequences of different emission pathways. The selection of the metric depends also on the policy goals and their time horizon.[101]

65. On progress made in determining metrics for adaptation, the IPCC explained that there is no single metric for assessing adaptation effectiveness and needs. This assessment is based on the recognition that the best adaptation options address multiple dimensions of vulnerability and contribute to other mitigation and sustainable development goals. It is therefore very difficult to apply an additionality criterion while evaluating the effects of

---

[96] The 2014 report is available at <http://www.unep.org/publications/ebooks/emissionsgapreport2014/>.

[97] The 2014 report is available at <http://www.unep.org/climatechange/adaptation/gapreport2014/>.

[98] See annex IV, paragraph 110.

[99] See annex IV, paragraph 102.

[100] See annex II, paragraph 65, annex III, paragraph 126, and annex IV, paragraph 86. See also footnote 10 and paragraph 23 above.

[101] See annex II, paragraph 27.

adaptation investments,[102] and no standardized methodology exists to quantify the benefits of adaptation.[103]

Message 7

We know how to measure progress on mitigation but challenges still exist in measuring progress on adaptation

A generally accepted metric exists for aggregating and measuring overall progress on mitigation, but no single metric exists to quantify and aggregate the overall progress on adaptation. Similarly, a widely accepted metric to measure overall progress on reducing risks of climate impacts by adaptation would be required in the context of a global risk management framework.

2. Progress in terms of mitigation and adaptation

66. On the aggregated effects of steps taken by Parties, the SED addressed the following: trends in stocks and flows of GHG emissions; the effectiveness of past mitigation policies; information from Parties on their emission reduction efforts; and efforts made by Parties in identifying and addressing their adaptation needs.

67. Regarding **past and current global GHG emissions**, WGIII found that growth in global GHG emissions has accelerated despite mitigation efforts and the global economic crisis, and that emission growth between 2000 and 2010 was greater than in any of the previous three decades (figure 9).[104] In addition, about half of the cumulative anthropogenic CO_2 emissions between 1750 and 2010 occurred in the last 40 years.[105] The IPCC and WMO also underscored that this happened while roughly half of those emissions were absorbed by the oceans and the terrestrial biosphere.[106]

68. In terms of **progress in 2030**, the IPCC explained that the risks associated with negative emission technologies are significantly lower if annual global GHG emissions in 2030 are below 50 Gt CO_2 eq[107] than if they are in the range of 50–55 Gt CO_2 eq. These risks are very high for annual emissions over 55 Gt CO_2 eq in 2030 (figure 8). UNEP explained that the current global emissions gap is close to what was assessed in 2013, and that the gap has been almost constant for the past five years.[108] Based on several variants of current pledges, UNEP estimated that the emissions gap will be 7–10 Gt CO_2 eq in 2025, and significantly larger in 2030, at 14–17 Gt CO_2 eq (figure 10).[109]

---

[102] See annex III, paragraph 62.

[103] See annex III, paragraph 92.

[104] See annex III, paragraph 110.

[105] For information on GHG emissions from WGI, see annex II, paragraphs 54 and 55.

[106] See annex II, paragraph 55, and annex IV, paragraph 329.

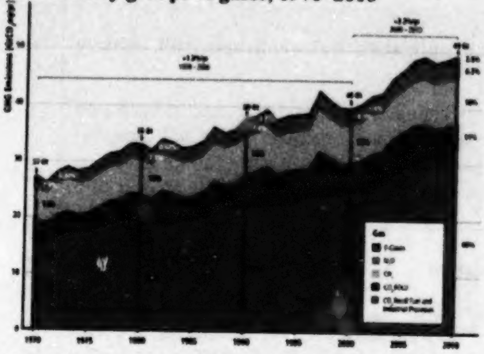
[107] Note that global GHG emissions in 2010 were at this level and that, since then, emissions have increased further.

[108] See annex IV, paragraph 110.

[109] See annex IV, paragraph 112.

Figure 9

Total annual anthropogenic greenhouse gas emissions by groups of gases, 1970–2010



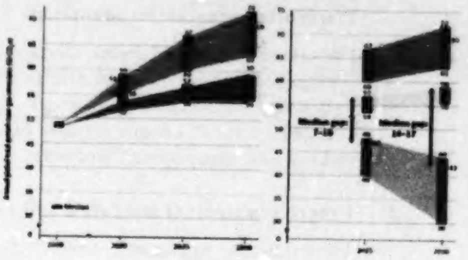
Source: Summary for policymakers in the contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.1.

Note: The figure illustrates that emission growth has accelerated in the last decade.

Abbreviations: CO_2 eq = carbon dioxide equivalent, F-gases = fluorinated gases, FOLU = forestry and other land use, GHG = greenhouse gas.

Figure 10

The emissions gap in 2025 and 2030



Source: Slide 4 of the presentation by Mr. John Christensen (United Nations Environment Programme), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_christensen.pdf>.

Note: The figure shows, based on Cancun pledges, the UNEP estimates that the emissions gap will be 7–10 Gt CO_2 eq in 2025, and significantly larger in 2030, at 14–17 Gt CO_2 eq.

Abbreviation: CO_2 eq = CO_2 equivalent.

69. In response to requests for clarification by Parties **on the reaction of sinks**, WMO indicated that there is uncertainty plus risks that sinks may change over time owing to the great inter-annual variability of the sinks, as well as the uncertainty about their future and the risk that this entails.[110]

70. On the **effectiveness of past policies**, the IPCC and UNEP emphasized that the current Cancun pledges are more consistent with pathways limiting global warming to 3 °C than 2 °C by the end of the century.[111] The IPCC also reported that from 2007 to 2012, the share of global emissions produced by countries with national climate policies rose from 45 to 67 per cent, and that these policies have not yet sufficiently influenced the emissions trend towards a reversal.[112] Emissions trading systems introduced to date suffer from caps that are too lenient and have thus experienced price decreases.[113] The World Bank reported on progress on eliminating fossil fuel subsidies and on carbon pricing, stressing the large co-benefits to development and well-being of the latter.[114]

71. **Parties sought clarification** on the effectiveness of emissions trading systems and carbon taxes, the removal of fossil fuel subsidies, the cost-effectiveness of commoditizing carbon in developing countries, and the price of carbon.

72. The IPCC indicated that there is agreement regarding the good performance of carbon taxes over the past 20 years, and that experiences with emissions trading over the past 10 years have been mixed.[115] The IPCC underlined that while a large number of clean development mechanism (CDM) projects have been generated, experts debate whether

---

[110] See annex IV, paragraph 329; see also annex II, paragraphs 56, 61 and 73.

[111] See paragraph 57 above, annex III, paragraphs 113 and 145, and annex IV, paragraph 110.

[112] See annex III, paragraph 144.

[113] See annex III, paragraph 148.

[114] See annex IV paragraph 119.

[115] See annex III, paragraph 161.

market-based mechanisms always fulfil the environmental integrity target.[116] Discussions, however, pointed to mitigation achieved and the finance mobilized through CDM projects. The IPCC also indicated that the assessment of policies shows the key role played by a consistent carbon price over a long period for the effectiveness of projects.[117]

73. Similarly to the World Bank (see para. 70), the IEA reported successful examples of eliminating fossil fuel subsidies. The World Bank added that in countries with weak institutions and low incomes, carbon taxes are much simpler than market-based instruments. Both carbon taxes and market-based instruments aim to raise revenue, which can be used to alleviate the shock of fossil fuel subsidy reforms.[118]

74. On **national information**, as indicated in a note on national information prepared by the secretariat,[119] challenges remain in bringing together the best available information from science and up-to-date reports from Parties and other processes under the Convention: a number of reports from the measurement, reporting and verification process were not available in time to be considered in the 2013–2015 review.[120]

75. **On progress on adaptation,** the Adaptation Committee reported on enhanced adaptation action in the context of the 2 °C limit to global warming, describing the three workstreams of its 2013–2015 workplan: technical support and guidance to Parties on adaptation action; technical support and guidance to Parties on means of implementation; and awareness-raising, outreach and sharing of information. The Adaptation Committee also described progress and lessons learned in the formulation and implementation of national adaptation plans (NAPs), noting that many programmes and activities that countries have been and are supporting already contribute to the objectives of the NAP process. The Adaptation Committee also stressed the need for appropriate monitoring and evaluation frameworks for adaptation that are tailored to country needs and circumstances.[121]

76. UNEP defined adaptation gaps, including the difference between what can be achieved with enhanced adaptation action and what society deems as the goal in terms of adaptation. This societal goal is not zero because society is ready to tolerate some amount of climate change impacts, which are determined by local cost-benefit analyses, and because some impacts are beyond our technical or physical ability to adapt.[122]

77. **Parties sought clarification** on: the fact that the Adaptation Committee has no specific focus on the long-term global goal; whether the recommendation to mainstream adaptation in development planning is appropriate for the least developed countries (LDCs); the importance of coordination among the three Rio Conventions in relation to NAPs; the term "societally desirable adaptation"; and how to address the adaptation gap.

78. The Adaptation Committee stated that despite the absence of a specific reference to the long-term global goal in its workplan, it would be difficult to argue that NAPs are not contributing to the achievement of the long-term global goal.[123] Experts indicated that whether countries decide to mainstream adaptation or carry out stand-alone projects depends on the types of hazards and exposure they face. In the case of LDCs, the consideration of reducing vulnerability comes as a complement to the second objective of

---

[116] See annex III, paragraph 161.
[117] See annex III, paragraph 189.
[118] See annex IV, paragraphs 172 and 181.
[119] FCCC/SB/2014/INF.3.
[120] See annex IV, paragraph 22.
[121] See annex IV, paragraphs 195–201.
[122] See annex IV, paragraph 103, and figure 74.
[123] See annex IV, paragraph 240.

NAPs, namely the integration of adaptation to climate change into other policies.[124] The Adaptation Committee stated that the collaboration in the processes under the three Rio Conventions could materialize in the context of ecosystem-based adaptation in the next workplan of the Adaptation Committee, which is under development.[125]

79. UNEP explained that the term "societally desirable adaptation" in the *Adaptation Gap Report* is based on the contribution of WGII to the AR5 and describes how to move from a level of potential adaptation that is technically and economically feasible to what will actually happen on the ground.[126]

80. The IPCC clarified that the AR5 indicates that while adaptation and mitigation take place at different timescales, we need to work on adaptation, mitigation and development at the same time. UNEP called for the adaptation gap to be kept as small as possible, which will be also achieved through progress in mitigation.[127]

Message 8

The world is not on track to achieve the long-term global goal, but successful mitigation policies are known and must be scaled up urgently

Greenhouse gas emission growth has accelerated, reaching a record high during the decade 2000–2010. The Cancun pledges are only consistent with the long-term global goal with pathways that require a much higher mitigation response later. Moreover, policies in place have had a limited impact on bending the emissions curve downward. However, successful mitigation policies have been identified and progress is being made on scaling them up, in particular in relation to putting a price on carbon and promoting otherwise low-carbon technologies, so that their share becomes dominant. **We need benchmarks for sound climate policy in the light of national circumstances.**

National information was not made available in a balanced manner for consideration by the structured expert dialogue, but such information could be considered in future reviews.

3. Consideration of means of implementation

81. On **technology**, the IPCC, IEA and UNEP experts indicated that many of the technologies required to achieve the 2 °C pathways are already available, but their deployment is not on track for reaching that goal.[128] The required technology deployment is often impeded by social, political and economic barriers rather than technology transfer issues, meaning that the role of social, political and organizational aspects needs to be addressed.[129] In general research and development play a key role in bringing and adjusting existing technologies to local conditions.[130]

82. IEA stressed the need for accelerating innovation in key technologies. In the short term, renewables and energy efficiency would be key in delivering emission savings. Additionally, there is a need for making investments now to ensure that technologies

---

[124] See annex IV, paragraph 252.
[125] See annex IV, paragraph 254.
[126] See annex IV, paragraph 163.
[127] See annex IV, paragraph 170.
[128] See annex III paragraph 101, and annex IV, paragraphs 107 and 128.
[129] See annex III, paragraphs 101 and 106.
[130] See annex IV, paragraph 107.

related to CCS and end-use fuel switching, including the electrification of transport, will be available when they are needed.[131]

83. The TEC reported on the key milestones in the technology process under the Convention, culminating with the 2010 establishment of the Technology Mechanism, which comprises the TEC and the CTCN. The TEC reported on progress related to the technology needs assessments carried out by Parties and aimed at identifying priorities for mitigation and adaptation technologies.[132] The CTCN reported on progress made towards enhanced action on the development and transfer of technology for action on climate change.[133]

84. IPCC experts noted that the AR5 underlined the importance of enabling environments for technology transfer, including institutional arrangements, and the provision of finance and the capacity to absorb the technologies adapted to each region.[134]

85. **Parties sought clarifications** on barriers to technology transfer, promising negative emission technologies, the deployment of BECCS, and the impact of bioenergy production on food security.

86. Current barriers to technology transfer identified by UNEP include financial barriers, regulatory and legal frameworks, technical barriers to the development and transfer of technology, and institutional and organizational barriers.[135] The World Bank stressed that trade barriers are obstacles to transfer of adaptation technologies.[136] The TEC underscored that factors other than funding are equally important for successfully transferring technologies.[137]

87. The IPCC and UNEP explained that the main promising negative emission technologies are either the sustainable deployment of BECCS, or enhancing land sinks in the agricultural and forest sectors, including by increasing forest cover. The IPCC and IEA added that CO_2 removal technologies are essential because of the need for negative emissions brought about by overshooting (see para. 26 above on the role of negative emissions and para. 56 above on the risks associated with scaling up such technologies).[138]

88. FAO said the impacts of bioenergy on food security are very diverse and depend not only on the area of production of biofuels, but also on the timescale used. In some countries, bioenergy production can have an impact on food prices, but can also drive development, lift people out of poverty and reduce energy poverty.[139]

89. On **capacity-building**, the SBI reported progress made under the Durban Forum on capacity-building and the Dialogue on Article 6 of the Convention, noting that they contribute to: disseminating knowledge by promoting discussions among experts and practitioners; identifying lessons learned; replicating good practices and fostering action towards emission pathways consistent with the 2 °C limit; and fostering education and building capacity for well-informed assessments of the adequacy of the long-term global goal and the overall progress towards that goal.[140]

---

[131] See annex IV, paragraph 135.
[132] See annex II, paragraph 74.
[133] See annex IV, paragraphs 228–232.
[134] See annex IV, paragraphs 97 and 98.
[135] See annex IV, paragraph 190.
[136] See annex IV, paragraph 190.
[137] See annex II, paragraph 82.
[138] See annex III, paragraphs 115 and 120, and annex IV, paragraph 162.
[139] See annex IV, paragraph 179.
[140] See annex IV, paragraphs 218–225.

90. **Parties sought clarification** on how the CTCN plans to collaborate with the Durban Forum on capacity-building, links between the CTCN and other programmes, and capacity-building projects under the CTCN.

91. The CTCN explained that most of its activities are in capacity-building, which underscores the importance of coordinating the work of the CTCN with the Durban Forum. Additionally, the CTCN helps countries to reformulate their requests for services if they are not clearly defined, carries out an 'incubator programme' for LDCs to help them define and identify their technology problems, and organizes webinars that provide training on specific climate-related technologies.[141] The CTCN is careful not to duplicate capacity-building activities of other bodies, and is looking at working in synergy with the Adaptation Fund on capacity-building and preparedness activities.[142]

92. On **finance**, the IPCC reported that there is no widely accepted definition of climate finance and that overall climate finance is estimated at USD 343–385 billion per year, with public climate finance flows to developing countries amounting to USD 35–49 billion per year and private ones falling in the range of USD 10–72 billion per year.[143]

93. On whether the current levels of climate finance are adequate, the IPCC and the SCF indicated that emission scenarios that limit warming to below 2 °C above pre-industrial levels require resources for addressing climate change to be scaled up considerably.[144] The SCF added that some projections indicate that current spending on 'brown' technologies will continue to grow faster than spending on renewable technologies.[145] Regarding mitigation, IEA reported that investment in energy supply has doubled since 2000 and that investment in renewables was scaled up considerably between 2000 and 2011; however, fossil fuels still dominate energy supply investments.[146]

94. The IPCC, the SCF and UNEP emphasized that although spending on adaptation has increased, the current focus remains on mitigation.[147] UNEP estimated that public finance committed to activities with explicit adaptation objectives was in the range of USD 23–26 billion in 2012–2013, of which 90 per cent was invested in developing countries. Only about 2 per cent of total adaptation finance came from multilateral mechanisms (USD 0.6 billion committed for developing countries in 2013), but this is a largely increasing trend.[148] UNEP underscored the difficulty of distinguishing between finance made available for adaptation and that for development or other purposes.

95. The Adaptation Committee reported that organizations and agencies need to consider their organizational mandates, set-ups and resources in the light of the long-term nature of the NAP process. For many Parties, there is a lack of clarity on procedures for applying for funding for the NAP process. Some Parties therefore suffer from inadequate and unpredictable financing, which hinders the further scaling-up and mainstreaming of adaptation into national development planning. UNEP warned that a major adaptation funding gap is likely, particularly after 2030.[149]

---

[141] See annex IV, paragraph 235.
[142] See annex IV, paragraph 247.
[143] See annex III, paragraph 178.
[144] See annex II, paragraph 76, and annex III, paragraph 179.
[145] See annex II, paragraph 76.
[146] See annex IV, paragraph 129, and figure 82.
[147] See annex II, paragraph 77, annex III, paragraph 178, and annex IV, paragraph 105.
[148] See annex IV, paragraph 105.
[149] See annex IV, paragraph 104.

96. The GCF reported on work to "move to full scale operations", highlighting that it had reached the target of USD 10 billion in resource mobilization. It also outlined future steps that need to be taken to enable it to start committing resources.[150]

97. **Parties sought clarification** on the range of estimates of public and private climate finance flows, the difficulty of defining adaptation finance, the high percentage of climate flows directed towards mitigation, leveraging private sector finance, and issues related to the operationalization of the GCF.

98. Regarding the definition of climate finance, experts indicated that the debate is still ongoing as to whether climate finance is more than just the incremental finance that drives funds from high-carbon to low-carbon investments.[151]

99. On the finance gap, the World Bank indicated that infrastructure finance is lacking USD 1.0–1.5 trillion per year[152] and that carbon pricing could provide some of the financing needed to achieve the long-term global goal.[153] The GEF highlighted the importance of: mainstreaming private sector engagement in climate financing; market transformation through risk reduction in capital-intensive investment; more efforts to enhance enabling environments through capacity-building and technical assistance; and strengthening efforts to build the necessary support infrastructure and policy frameworks to further scale up technology investment and achieve transformational impact.[154] Private sector finance, which constitutes the largest part of climate finance, is mostly channelled to mitigation.[155]

100. As far as adaptation finance, UNEP clarified that the *Adaptation Gap Report* only includes funding for adaptation that is qualified as "significant" or "principal". This excludes disaster relief, although funding for disaster risk management is increasingly being included in estimates of adaptation finance flows. There are high uncertainties in the cost estimates for adaptation because not much data is available to assess the effect of the measures. Additionally, since private sector adaptation activities cannot be tracked, they are not included in estimates of finance flows.[156]

101. The GCF clarified that it is currently converting pledges by governments into agreements and that the fiduciary information disclosed by entities seeking accreditation with the GCF are treated as confidential.

4. Equity

102. The IPCC noted the importance of assessing the issues of equity, justice and fairness raised by mitigation and adaptation action, including the following: different past and future contributions to the accumulation of GHGs in the atmosphere; different capacities to undertake mitigation and adaptation; and varying challenges and circumstances.[157] Limiting the effects of climate change is necessary to achieve sustainable development and equity, including poverty eradication, while taking into account possible risks from mitigation actions and adaptation obstacles of particular relevance for the more vulnerable and disadvantaged.[158]

---

[150] See annex IV, paragraph 306–308.

[151] See annex II, paragraph 95, and annex III, paragraph 165.

[152] See annex IV, paragraph 159.

[153] See annex IV, paragraph 189.

[154] See annex II, paragraph 78.

[155] See annex III, paragraph 184.

[156] See annex IV, paragraph 185.

[157] See annex IV, paragraph 34.

[158] See annex III, paragraphs 67, 68, 70 and 71, and annex IV, paragraph 47.

103. On equity and equitable effort-sharing in relation to achieving the long-term global goal, the IPCC presented three lines of argument: Parties have accepted legal commitments to act equitably against climate change; it is morally proper to allocate burdens associated with the common global climate challenge according to ethical principles; and equitable effort-sharing will be necessary if the climate challenge is to be effectively met.[159] Furthermore, a cooperative agreement based on effort-sharing that is seen as equitable and based on ethical principles may lead to more effective cooperation, and could reduce the potential risk of costs of climate action constraining development.[160]

104. The IPCC indicated that a regional breakdown of mitigation expenditure based on mitigation potential (i.e. where each region undertakes mitigation up to a common, equal marginal abatement cost) reflects a distribution of costs that is the opposite of what might be expected if the mitigation burden were instead shared according to equity, which is the issue at the core of the effort-sharing problem. Effort-sharing schemes based on ethical principles have the potential to yield a more equitable cost distribution across countries than those based on mitigation potential.[161]

105. **Parties sought clarification** on regional differences in mitigation costs and the assumptions used for their estimation. The IPCC clarified that Africa would have the highest mitigation costs because costs are calculated as a percentage of GDP, which is low in Africa, and because estimates take into account not only present emission levels, but also their projected growth.[162]

Message 9

We learned from various processes, in particular those under the Convention, about efforts to scale up provision of finance, technology and capacity-building for climate action

Many of the technologies required to achieve the long-term global goal are already available, but their deployment is not on track. Various barriers to their deployment and transfer have been identified. There is no widely accepted definition of climate finance, and uncertainties remain in the tracking of climate finance flows, in particular for adaptation finance and private finance, and to a lesser extent also for mitigation finance. Discussions are ongoing in various processes under the Convention regarding the resources required to address climate change under emission scenarios that limit the temperature increase to below 2 °C.

Institutions and processes launched under the Convention on technology and capacity-building have built a foundation for much greater effort, and progress has been achieved in the operationalization of the Green Climate Fund. The level of action now needs to be increased on all fronts.

D. Consideration of strengthening the long-term global goal, including in relation to a temperature rise of 1.5 °C

106. Regarding the strengthening of the long-term global goal, the SED addressed the following: the difference in projected risks of climate impacts between 1.5 °C and 2 °C of warming, in particular in relation to extreme events or tipping points; the regional differences in projected risks of climate impacts between 1.5 °C and 2 °C of warming; and

---

[159] See annex III, paragraph 173.

[160] See annex III, paragraphs 173, and annex IV, paragraph 34.

[161] See annex III, paragraph 176.

[162] See annex III, paragraph 183.

the feasibility of the 1.5 °C limit, in particular in relation to mitigation scenarios that limit global warming to below 1.5 °C, and the risks associated with such a limit, notably that of overshooting the 1.5 °C limit and the concomitant triggering of climate change accelerating feedbacks.

107. Although literature on the projected risks and impacts at 1.5 °C of warming is limited, IPCC experts made efforts to identify a proxy for the impacts expected at 1.5 °C of warming: using the concept of "one unit of risk",[163] the IPCC indicated that for each key risk, an average of 0.5 additional risk units were estimated for the difference between 1.5 °C and 2 °C of warming above pre-industrial levels. This type of analysis could extract additional information across regions and sectors for these two levels of global warming.[164]

108. Experts emphasized the high likelihood of meaningful differences between 1.5 °C and 2 °C of warming regarding the level of risk from ocean acidification and of extreme events or tipping points, because impacts are already occurring at the current levels of warming; risks will increase with further temperature rise.[165] In particular, experts from the IPCC, SPREP, CCCCC and AMAP indicated that the difference in projected risks between 1.5 °C and 2 °C of warming is significant for highly temperature-sensitive systems, such as the polar regions, high mountains and the tropics, as well as for some other regions, in particular low-lying coastal regions.[166] The IPCC further stressed that regional food security risks are significantly different between 1.5 °C and 2 °C of warming, pointing to the example of Africa, where in some countries the reduction in staple crop yields is projected to be higher than the global average.

109. Experts also underscored that challenges in the understanding of some physical systems, such as glaciers and permafrost, hinder the estimation of projected risks of climate impacts at 1.5 °C versus 2 °C of warming, and that for agricultural and human systems, the difference between a 1.5 °C and a 2 °C temperature rise above pre-industrial levels is becoming increasingly difficult to assess.[167] They added that in the light of the difficulties in predicting the risks of climate change, there is value in taking a precautionary approach and adopting a more stringent target.[168]

110. On the other hand, some benefits of scenarios with 1.5 °C instead of 2 °C of warming were identified and include the following: most terrestrial and marine species would be able to follow the speed of climate change; up to half of coral reefs may remain; sea level rise may remain below 1 m; some Arctic sea ice may remain; ocean acidification impacts would stay at moderate levels; and more scope for adaptation would exist, especially in the agricultural sector.[169]

111. Available mitigation scenarios are characterized by a temperature overshoot and large-scale application of CO_2 removal technologies, immediate mitigation action, a rapid scaling-up of the full set of technologies, and development along a low-energy demand pathway.[170]

---

[163] Defined as the transition of a risk from one level to the next (e.g. from 'very low' to 'low' or from 'medium' to 'medium-high'). For the caveats regarding the comparison of projected risks and impacts at 1.5 °C and 2 °C of warming, see annex IV, paragraph 57.

[164] See annex III, paragraph 54, and annex IV, paragraph 56.

[165] See annex III, paragraph 54, and annex IV paragraph 204.

[166] See annex III, paragraph 35 and 52.

[167] See annex III, paragraph 54.

[168] See annex IV, paragraph 57.

[169] See annex III, paragraph 53, and annex IV, paragraphs 43 and 56.

[170] See annex III, paragraph 114, and annex IV, paragraph 66.

112. **Parties sought clarification** on: the difference in impacts on both oceans and land of global warming of 1.5 °C and 2 °C above pre-industrial levels; the window of opportunity in relation to a 1.5 °C and a 2 °C temperature rise; the required technologies, their scaling-up, the technology portfolio and the costs related to achieving the 1.5 °C scenarios; the comparison between the increased costs of mitigation, the reduced costs of adaptation and the avoided non-monetary impacts between the 1.5 °C and 2 °C warming limits; and whether overshooting scenarios would increase the risk of carbon cycle feedbacks and ocean acidification.

113. On the **projected risk of climate impacts at 1.5 °C of warming**, the IPCC indicated that near-term risk in a situation with warming of around 1.5 °C could serve as an operational tool to provide an approximate indication of the risks of climate impacts of a long-term warming of 1.5 °C.[171] Some experts warned that current levels of warming are already causing impacts beyond the current adaptive capacity of many people, and that there would be significant residual impacts even with 1.5 °C of warming (e.g. for sub-Saharan farmers), emphasizing that reducing the limit to 1.5 °C would be nonetheless preferable. The CBD secretariat drew attention to the increased risk of extinction when going from 1.5 °C to 2 °C of warming, while noting the uncertainties on how this will happen.[172]

114. In terms of **feasibility, costs and risks** of the 1.5 °C scenarios, the IPCC indicated that overshooting is a typical feature of low-emission scenarios, with its related risks.[173] Higher emission scenarios come with higher risk of feedbacks that accelerate climate change, so keeping the temperature rise below 1.5 °C could help control carbon cycle feedbacks and reduce risks from them.[174] The technologies required for the 1.5 °C scenarios are the same as for the 2 °C pathway, but need to be deployed faster, and energy demand needs to be reduced earlier, implying a higher cost than in the 2 °C scenarios.[175] The IPCC also noted that some technologies and policies required to limit warming to 1.5 °C may negatively impact poverty reduction efforts. However, impacts are already occurring and risks will increase with the degree of temperature rise. In general, pathways limiting warming to below 1.5 °C by the end of the century are similar to those limiting warming to 2 °C, but call for more immediate mitigation action and an additional scaling-up of the challenging features of the 2 °C scenarios, such as the scaling-up of CO_2 removal technologies and of the full set of low-carbon technologies.[176]

115. On the **comparison of costs and avoided** impacts between the 1.5 °C and 2 °C warming limits, the IPCC drew a distinction between mitigation costs and net benefits, noting that cost implications would not determine whether or not to pursue the 1.5 °C warming limit.

---

[171] See annex II, paragraph 50, and annex III, paragraph 27.

[172] See annex IV, paragraph 244.

[173] See annex III, paragraph 121.

[174] See annex II, paragraph 66.

[175] See annex III, paragraph 151.

[176] See annex IV, paragraphs 60 and 66.

Message 10

While science on the 1.5 °C warming limit is less robust, efforts should be made to push the defence line as low as possible

The science on the 1.5 °C warming limit is less robust than for the 2 °C warming limit or warming beyond this limit. Consequently, assessing the differences between the future impacts of climate risks for 1.5 °C and 2 °C of warming remains challenging. More scientific findings are likely to become available in the future, and considerations on strengthening the long-term global goal to 1.5 °C may therefore have to continue.

Nevertheless, limiting global warming to below 1.5 °C would come with several advantages in terms of coming closer to a safer 'guardrail'. It would avoid or reduce risks, for example, to food production or unique and threatened systems such as coral reefs or many parts of the cryosphere, including the risk of sea level rise. On the other hand, this implies a more pronounced reliance on negative emissions with associated risks, including those from land-use change, as well as increases in mitigation costs in comparison with the 2 °C warming limit, and requires a larger temperature overshoot, which also carries certain risks.

However, while it is unclear whether the difference between 2 °C and 1.5 °C of warming is really only a matter of a gradual increase in risks or also includes some non-linear effects, as some evidence from the palaeo-record indicates,[a] Parties may wish to take a precautionary route by aiming for limiting global warming as far below 2 °C as possible, reaffirming the notion of a defence line or even a buffer zone keeping warming well below 2 °C.

[a] See annex II, paragraphs 38–40, 51 and 67, footnote 51 above, and figure 16.

IV. Concluding remarks and possible next steps

116. The SED sessions brought together many government delegates and experts from all regions, as well as civil society representatives. During each session, we made great efforts to ensure a geographical, gender, regional, institutional balance, as well as to maintain an equilibrium between the two themes of the review (figure 1). We did this both in terms of presentations and the time allocated to the discussions. The discussions were substantial, with Parties and experts engaging in a remarkably constructive and rich dialogue. We believe the productive and informative discussions at SED sessions supported Parties in internalizing the key findings of all the contributions to the AR5 and of the work in the processes under the Convention and of other organizations and regional bodies. We also believe that the SED has proved to be a valuable addition to the science–policy interface in general, as it has informed and supported policy formulation while taking into account various values and recognizing that what constitutes an intolerable risk may differ across sectors, regions and countries. We also consider that the face-to-face conversation with the policymaking community was essential for scoping future assessments of the science of climate change.

117. The SED has shown that limiting global warming to below 2 °C above pre-industrial levels would significantly reduce the projected risks of climate change, allowing, in the light of Article 2 of the Convention, the adaptation of many ecosystems, protecting food production and enabling economic development to proceed more sustainably. However, the SED has also illustrated that, in some regions and vulnerable ecosystems, high risks are projected even for warming above 1.5 °C. We are therefore of the view that Parties would profit from restating the long-term global goal as a 'defence line' or 'buffer zone', instead of a 'guardrail' up to which all would be safe. This new understanding would then probably also favour emission pathways that will limit warming to a range of temperatures below 2 °C. In the very near term, such aspirations would keep open as long as possible the option

of a warming limit of 1.5 °C, and would avoid embarking on a pathway that unnecessarily excludes a warming limit below 2 °C.

118. On theme 2 of the review, the SED has clearly shown that not only are we not on track to meet the long-term global goal, but the current emission rate is accelerating. It seems advisable, including according to the many experts consulted, to scale up current mitigation, adaptation, finance, technology and capacity-building efforts so as to enable all Parties to reach the long-term global goal. To that end, emissions need to be cut significantly and immediately, in particular to minimize effort and keep it cost-effective. Additionally, since carbon neutrality should be achieved in the second half of this century in the light of the limited global CO_2 budget, prompt and decisive climate action is needed. To address equity issues and make progress in reducing poverty in general, efforts need be strengthened to promote sustainable development in ways that minimize impediments from climate change by promoting mitigation as well as adaptation in an appropriate and well-balanced manner and always taking into account national circumstances.

119. Looking at future reviews, we hope that the work done by the SED under the 2013–2015 review will inspire future work of a similar nature. More specifically, the next review is expected to make use of the more complete national information contained in reports from Parties and other processes under the Convention, since all of the reports from the measurement, reporting and verification process are scheduled to be available by 2017. Therefore, the next review could bring together the best available knowledge not only from the scientific community, but also from national information sources.

120. Furthermore, the SED has identified that gaps in relevant knowledge exist for various regions, especially vulnerable ones such as Africa, the Pacific, the Caribbean and the Arctic. The SED has also highlighted various other vulnerable areas where additional research and discussions are required in order to better inform policymakers on the adequacy of the long-term global goal and overall progress made towards it. Such topics include: the evaluation of the costs of adaptation; the value assessment of the co-benefits of climate change mitigation; the relationship between ocean acidification and temperature increase; a broader and scientifically more robust assessment of the 1.5 °C warming limit; the impacts of climate variability and extremes on crop yields; the impacts of climate change on nutrition, livestock and marine fisheries, as well as on pests and diseases; and human health issues such as desert dust as a climate forcer.

121. Within the global risk management framework, it is clear that we need to link the cycle of assessments of the adequacy of the long-term global goal and the progress made towards achieving it with other processes and assessment cycles, as is for example done under the Ad Hoc Working Group on the Durban Platform for Enhanced Action. Such a cycle could include a consideration of the next IPCC products. The SED could reconvene to consider both these future reports and the national information that will become available by then.

122. We hope that the work of the SED has informed Parties by providing the best available scientific knowledge, that it was guided by the principles of equity and common but differentiated responsibilities and respective capabilities, and that it took into account the relevant principles and provisions of the Convention. We also hope that we have enabled Parties to make well-informed decisions on the adequacy of the long-term global goal and on the measures and means of implementation needed to make good progress towards achieving this goal. We, the co-facilitators, hope to have served us all on our challenging journey towards a future with minimal dangerous interference with our planet's climate system.

Annex I

Summary report on the first structured expert dialogue on the 2013–2015 review

I. Introduction

A. Mandate

1. In response to the mandates provided in decisions 2/CP.17 and 1/CP.18, the Chairs of the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI) sent a joint message to Parties, on 11 March 2013, signalling the intention to organize an in-session workshop on the 2013–2015 review (hereinafter referred to as the review) at the thirty-eighth sessions of the subsidiary bodies and inviting Parties to submit their views on the available information that should be considered at that workshop.[1] The secretariat received six such submissions from Parties and two from non-governmental organizations (NGOs).[2] On the basis of the mandate for the review and the aforementioned submissions from Parties, the Chairs of the SBSTA and the SBI provided an informal note that outlined the organization and goals of the workshop.[3]

B. General objectives

2. The objectives of the workshop were to increase the understanding of existing scientific knowledge and explore how it could be used to address the two themes of the review: (i) the adequacy of the long-term global goal in the light of the ultimate objective of the Convention; and (ii) overall progress made towards achieving the long-term global goal, including a consideration of the implementation of the commitments under the Convention.[4]

II. Summary of the proceedings

3. The workshop was held on 5 June 2013 at the Maritim Hotel in Bonn, Germany, during the thirty-eighth sessions of the subsidiary bodies, and it was open to all Parties and observers. The discussions at the workshop focused on the two themes of the review described in paragraph 2 above. Additional information on the workshop, including the agenda for the workshop and copies of all presentations, is available on the web page of the structured expert dialogue (SED).[5]

4. The workshop was opened by Mr. Richard Muyungi, Chair of the SBSTA, and was facilitated by Mr. Zou Ji (China), one of the co-facilitators of the SED.

5. Under the first theme of the workshop, views were sought on possible ways to assess the adequacy of the long-term global goal using various sources of information. Three experts, from the World Meteorological Organization (WMO), the Intergovernmental Panel on Climate Change (IPCC) and the Hadley Centre, made presentations. The co-facilitator then provided the following guiding questions:

---

[1] <http://unfccc.int/files/parties_and_observers/notifications/application/pdf/message_to_parties_from_the_sbsta_and_sbi_chairs_2013_2015_review.pdf>.

[2] Available at <http://unfccc.int/7590.php>.

[3] <http://unfccc.int/files/methods_and_science/research_and_systematic_observation/application/pdf/informal_note_14_may_2013.pdf>.

[4] See decision 1/CP.18, paragraph 79.

[5] <http://unfccc.int/science/workstreams/the_2013-2015_review/items/8477.php>.

(a) How could IPCC information be used to carry out the review? How could such information be complemented by national and regional information, taking into account any concerns relating to the reopening of the IPCC findings?

(b) How could information from other relevant reports from United Nations agencies and other international organizations be used in the review?

(c) What technical work should be undertaken under the SED to assess the adequacy of the 2°C goal? Which analytical frameworks could be used to assess the impacts and risks of the 2 °C goal?

6. Reflecting on the questions above, representatives of the Alliance of Small Island States (AOSIS), European Union and Switzerland gave presentations, followed by an open discussion.

7. The deliberations under the second theme of the workshop were initiated by a scene-setting presentation made by the secretariat. The co-facilitator then introduced the following guiding questions:

(a) How could information from the IPCC, Parties and United Nations agencies and other international organizations be used in the review?

(b) Which institutions, bodies and processes could provide relevant information to the review?

(c) What technical work should be undertaken under the SED to assess the overall progress made towards achieving the long-term global goal, without duplicating the work of the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP)?

8. Reflecting on the questions above, representatives of China, Philippines and New Zealand gave presentations, followed by an open discussion.

9. On the NGO side, a representative of Climate Action Network-International made a statement. The proceedings of the workshop were broadcast on the Web, and social media were used to increase the participation of Parties and observers outside the workshop venue.

10. At the closing the workshop, the co-facilitator thanked Parties for their constructive discussions and the NGOs for their contribution.

III. Summary of the workshop discussions

A. Theme 1: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention

1. Presentations by experts and Parties' reflections

11. The first presentation, by Mr. Jerry Lengoasa (WMO), focused on the status of the global climate, drawing on the recent publication of the WMO statement on the status of the global climate in 2012.[6] He described the observed changes in the physical system, showing upward trends in the anomalies for global temperature, in sea level, humidity and ocean heat content and downward trends in the extent of sea ice, glacier mass balance and area of snow cover.[7]

12. He noted the following: a daily carbon dioxide (CO_2) concentration of above 400 ppm was reported in 2012 by the Global Atmosphere Watch stations; the global land and ocean surface temperature was estimated to be 0.45 °C±0.11 °C above the 1961–1990 average of 14 °C; the years 2001–2012 were all among the top 13 warmest years on record; and the Arctic sea ice extent in 2012 showed the largest seasonal loss on record. He underlined the importance of the essential climate variables[8] in supporting the exchange of information, and also

---

[6] <http://library.wmo.int/pmb_ged/wmo_1108_en.pdf>.

[7] The presentation by Mr. Chris Field of IPCC (see paras. 13 and 14 below) emphasized that the changes in the Earth system are consistent with climate change.

[8] The variables cover the oceanic (18 variables), atmospheric (14 variables) and terrestrial (16 variables) domains.

noted that a substantial number of national climate records in temperature and precipitation were renewed and that a very high impact of extreme climate events was recorded in 2012, including heatwaves, drought and floods.

13. The second presentation was made by Mr. Chris Field (IPCC) on the IPCC assessments and their possible use to assess the long-term global goal, with a special focus on dangerous anthropogenic interference. He highlighted that an assessment of what constitutes such interference must involve value judgements that go beyond the methods and insights of science. He suggested that the following four elements be included in the consideration of dangerous anthropogenic interference: the level of impacts to avoid; for which future world; with what probability that the impact will occur; and for which stakeholders. These elements are interconnected. For example, uncertainties mandate a risk management perspective, which requires an agreement on the probability of avoiding a given level of impact. Likewise, different future worlds will have an impact on the vulnerability of a given stakeholder, owing, for example, to variation in wealth, equity, infrastructure and institutions.

14. In addition, Mr. Field explained the core elements of the IPCC Fifth Assessment Report (AR5), including the use of risk-based framing, the presentation of impacts for a wide variety of possible futures and climate outcomes, the thorough description of uncertainty, and awareness of interactions and potential surprises. The presentation underlined the increase in the sensitivity of the system due to observed impacts of climate change (e.g. on wildfires and agricultural yields) and provided examples of recently observed extreme climate events, suggesting whether or not they were caused by climate change. It also illustrated the effect of increases in global average temperature on the risks to unique and threatened systems, on large-scale discontinuities and extreme weather events, as well as on aggregated impacts and the distribution of impacts.

15. Mr. Jason Lowe (Hadley Centre) said that the feasibility of limiting warming is influenced by the response of the climate system,[9] economic and technology development and the capabilities of policies and markets to create a situation favourable to emission reductions. He then illustrated the relationship between the global emission reduction rate per year and the time frame for the peaking of global emissions[10] for emission pathways compatible with a 50 per cent probability of limiting warming below 2 °C in 2100. He concluded that a late peaking would require negative emissions and would lead to potential competition for land between biofuels and food production,[11] and that there is still a 50 per cent probability of limiting warming below 2 °C without negative emissions, but the window of opportunity is narrow. He also stated that a 1.5 °C target would be possible with a lower probability or a temperature overshoot, and he questioned whether the resilience for such a target with overshooting could be treated in the same way as targets without overshooting, considering the limited science on temporary resilience.

16. Mr. Lowe highlighted the benefits of achieving the 2 °C goal compared with 'business as usual', such as reducing the number of people suffering as a result of the stress on water resources and river and costal floods, increasing spring wheat productivity, reducing the acidification of the oceans, and reducing the energy requirements for cooling. He noted that the estimated percentage of avoided impacts for 2 °C compared with 4 °C varies for the above examples and that these estimated percentages are relatively robust to the uncertainty of climate modelling compared with the uncertainty for absolute avoided impacts. He also noted that large-scale climate system thresholds may be affected by more than temperature,[12] underlined the significant role that the interactions among these thresholds might have on the overall risk of abrupt climate change, and suggested the application of multiple temperature targets, each with a separate probability (e.g. a 50 per cent probability of limiting temperature rise to less than 2 °C and a 90 per cent probability of limiting temperature rise to less than 4 °C).

---

[9] Temperature response to a given emission pathway.

[10] Based on climate-modelling results from the AVOID (Avoiding Dangerous Climate Change) programme (see <http://www.metoffice.gov.uk/avoid/what-is-avoid>).

[11] For example, a global emission reduction rate of 2–4 per cent could result in emissions peaking between 2015 and 2020, for cumulative emission budget by 2100 of between 0 and 200 Gigatonnes of CO_2.

[12] For example, the dieback of tropical forest is affected by the CO_2 concentration, as well as the length of the dry season, while the overturning of the Atlantic Ocean is affected by the atmospheric concentration of aerosols.

17. A representative of AOSIS stressed that the technical work to be undertaken should include an assessment of impacts and risks at different levels of CO_2 concentration and warming, including 1.5 °C, especially the risks of ocean acidification, global and regional sea level rise and irreversible changes in the physical, ecological and human systems, including for specific regions and key sectors and systems. Observations and projections relevant to local and regional circumstances should cover exposure and vulnerability to climate change, the resulting impacts, adaptation options and loss and damage.

18. In addition, he underlined that the SED should also consider current and near-term emission trends and global emission pathways, including target emission levels and budgets for achieving the long-term global goal with high probability; associated costs of, and technological options for, mitigation pathways; and the issues relating to the response of the climate system, such as climate sensitivity, the global carbon cycle, non-CO_2 forcing and climate projections. Regarding the issue of the use of information, he noted that, in addition to IPCC information, information from United Nations agencies and other international and regional organizations should be used in the review (see the appendix), in particular with regard to research findings for smaller countries, such as small island developing States and the least developed countries.

19. A representative of the European Union further elaborated on the risks at different levels of warming and evaluated those risks as manageable through adaptation for a temperature rise of 1–2 °C, significant for a 2–3 °C rise, and potentially disastrous for a 3–4 °C rise, on the basis of the species extinction rate, impact on food production, additional people exposed to water stress and the response of the climate system.[13] Regarding the global emission pathways, he suggested considering the probability of achieving the 2 °C goal, noting that for a 50 per cent probability, emissions should peak at 500 ppm CO_2 eq and stabilize at 450 ppm, while for a 75 per cent probability they should peak at 475 ppm and stabilize at 400 ppm.

20. A representative of Switzerland was of the view that Article 2 of the Convention indicates which scientific inputs should be considered by the SED (e.g. greenhouse gas concentration, dangerous anthropogenic interference with the climate system, ecosystems, food security and economic development in a sustainable manner) and he illustrated the danger of 'cherry-picking' data and literature on climate science. He then stressed that the IPCC provides the best scientific input and, therefore, should be the foundation for the review.

2. Discussions

21. Responding to the presentation made by the IPCC, a participant welcomed the approach of a risk-management framework and underscored that all available information, including regional information, should be taken into account when a value judgement is going to be made under the review. In addition, with regard to the presentation made by the representative of the European Union, she asked for the rationale for distinguishing manageable risks and significant risks, and whether such risks are perceived as global or regional. Furthermore, responding to the Swiss representative's presentation, she noted that regional information is as important as IPCC information.

22. Another participant explained her interpretation of the objective, principles and scope of the review and stressed the need for balance between the two themes. She noted that the adequacy of the long-term global goal is not only an issue of the number for the goal but also an issue of its context. Her views were supported by another participant, who stated that an integrated approach, assessing mitigation, adaptation and economic, social and political conditions, is needed to conduct the review. He also stressed that the assessment of what has to be done under the Convention to achieve the 2 °C goal is important.

23. Most Parties underlined the important role of science in the review. Some Parties stated that IPCC findings will be key information and that regional and national information could supplement the IPCC information, while others were of the view that regional and national information should be regarded as being at the same level as IPCC information.

---

[13] EU Climate Change Expert Group 'EG Science'. 2008. The 2 °C target: Background on Impacts, Emission Pathways, Mitigation Options and Costs, available at
<http://ec.europa.eu/clima/policies/international/negotiations/future/docs/brochure_2c_en.pdf>.
Eric Fee (Ed.) 2010. Scientific Perspectives after Copenhagen, available at
<http://www.eutrio.be/files/bveu/media/documents/Scientific_Perspectives_After_Copenhagen.pdf>.

B. Theme 2: overall progress made towards achieving the long-term global goal, including a consideration of the implementation of the commitments under the Convention

1. Presentations by experts and Parties' reflections

24. An introductory presentation was made by the UNFCCC secretariat on information gathering for the assessment of the overall progress made towards achieving the long-term global goal. After outlining the main sources of information for the review, he focused on information from Parties,[14] which he grouped into three categories, namely: submissions; national reports, including international assessment and review (IAR) and international consultation and analysis (ICA) reports; and information from other relevant reports from Parties and processes under the Convention. Regarding national reports, he stressed a possible issue relating to the date of publication of IAR and ICA reports, which will be available from 2014 and 2015, respectively. With regard to the above-mentioned other processes, he noted the need to identify processes that would be relevant to the review.

25. A representative of China was of the view that the objectives of the review are to facilitate the achievement of the ultimate objective of the Convention and to provide useful input to the ADP and various institutions under the Convention. After presenting his understanding on how the principles and provisions of the Convention would guide the review, he noted that the review is not a review of the Convention itself and suggested its focus should be on assessing the implementation of the commitments under the Convention. With regard to elements that should be addressed under theme 1, he mentioned the impacts of the 2 °C goal on ecosystems, the environment and social and economic aspects; adaptation costs; the impacts of mitigation efforts on developing countries; and current knowledge on alternative goals. In relation to theme 2, he mentioned the adequacy and implementation of mitigation commitments of Parties included in Annex I to the Convention (Annex I Parties), the provision of means of implementation by Parties included in Annex II to the Convention (Annex II Parties), and adverse social and economic impacts of the implementation of mitigation commitments on developing countries.

26. Regarding the use of information, he acknowledged that the IPCC is one of the key information sources and suggested that high priority should be given to information from Parties. He also stated that information from United Nations agencies and from existing institutions, bodies and processes is also important and complementary to the IPCC information. Regarding the technical work to be conducted under the SED, he suggested updating the information on financial and investment flows on the basis of previous work,[15] and the technology needs of developing countries on the basis of a new round of technology needs assessments.[16] He also provided some questions to be addressed, including on the emission trends of Annex I Parties and on the technology and financial needs of developing countries.

27. A representative of the Philippines supported the views presented by the representative of China and presented an integrated contextual framework for the review, which suggested that the implementation of the Convention should be the basis for assessing the progress on mitigation and adaptation towards achieving the LGTT. He illustrated that the level of progress will influence the amount of time available to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner, and will consequently determine the adequacy of the 2 °C goal. He provided questions corollary to the key assessment questions for the two themes of the review (e.g. is the 2 °C goal adequate? Is overall progress being made towards achieving the 2 °C goal?[17]) and suggested categories of information that will be needed to carry out the review.

28. Regarding the technical work to be conducted under the SED, he suggested assessments of implementation advances and gaps; incentives for, and barriers to, the implementation of commitments; the

---

[14] Decision 2/CP.17, paragraph 161(b), specifies the types of information received from Parties that should be included in the review.

[15] See <http://unfccc.int/resource/docs/2008/tp/07.pdf>.

[16] See <http://unfccc.int/ttclear/templates/render_cms_page?TNA_home>.

[17] For example, linked to the implementation of Article 4, paragraph 1(a), (b) and (d), paragraph 2(a) and (b), and paragraphs 3, 4, 5 and 7, of the Convention.

impacts of, and responses to, the implementation of commitments; and linkages and feedback loops arising from the implementation of commitments.

29. A representative of New Zealand, speaking on behalf of Australia, Canada, Japan, New Zealand, Norway and the United States of America, presented a view different from the two preceding presentations on elements to be discussed as part of the SED under theme 2, drawing on the mandate of the review to assess aggregate progress and the actions of all Parties. This involves assessing aggregate GHG emissions, trends and projections; the effectiveness of mitigation actions undertaken by all Parties; the aggregate mitigation commitments of all Parties and progress towards achieving those commitments; the implementation of commitments under the Convention; economic circumstances and capabilities of Parties; and cost-effective mitigation potential, clean energy technology and energy efficiency potential.

30. She suggested the following approach to the technical work under the SED: to discuss the findings of the IPCC, when available; to compile inputs into synthesis reports; and to keep it an open space in which to explore the best ways for the global community to achieve and maintain the long-term global goal. She also stressed the important role of information regarding the implementation of transparency provisions, including biennial reports and biennial update reports, and the role of the secretariat in compiling and systemizing information on progress, under the guidance of the co-facilitators of the SED.

2. Discussions

31. Responding to the proposal for an assessment of the commitments of developed country Parties, several participants commented that the global picture of the long-term global goal should be maintained in the review. Another participant suggested that the review should not duplicate work that is being undertaken elsewhere in the UNFCCC process.

32. Additional inputs by other participants included the following:

(a) Emphasized that the assessment of IPCC information is the starting point for the review and that such information should be supplemented by national and regional information, especially when large-scale data are interpreted for developing a policy on a small spatial scale;

(b) Explained their understanding of the long-term global goal, which is not just a simple temperature goal, but also includes goals for adaptation, technology and finance, and underlined that assessing the overall progress towards achieving the long-term global goal implies an assessment of the means of implementation provided, as implementation of actions will depend on the scale of the means of implementation;

(c) Stressed the importance of balance between the two themes of the review and suggested inviting IPCC experts on sustainable development, equity, investment and finance to make presentations under theme 2, and supported the view presented by the representative of China that the review is not a review of the Convention itself;

(d) Pointed out that reviewing finance or technology support will be understood as a review of the Convention. She noted that the decisions of the COP on the review make no reference to groups of Parties, and she stressed that the overall progress made by Parties encompasses all Parties' efforts towards achieving the long-term global goal.

33. Regarding the 'other processes'[18] to be considered in the review, one participant suggested that relevant outputs of processes under the Convention, such as on long-term finance, response measures and work done under the Nairobi work programme on impacts, vulnerability and adaptation to climate change, should be fed into the review. He also suggested that the consideration of inputs from IPCC AR5 should start after the completion and adoption of its reports.

---

[18] See paragraph 24 above.

C. Virtual participation

34. Participants who were not at the workshop venue were able to watch the event online via webcast and offer reactions, views or questions as input to the discussion on Twitter. Over 300 tweets were sent out by 140 contributors, reaching 230,000 people, including on the following:[19]

(a) The extent of avoided impacts in the 2 °C or 1.5 °C target scenarios;

(b) The implication for risks if the global emissions do not peak by 2020;

(c) The need to consider information from the International Energy Agency and World Bank publications (e.g. *World Energy Outlook*);

(d) The role of science, including what is dealt with in the political negotiations, what leads to action and what needs more awareness;

(e) The methodology to decide whether the 2 °C goal is adequate;

(f) The role of observers.

IV. Reflections

35. It is our perception that the discussions revealed some substantive and procedural issues that we should consider when preparing for the next meeting of the SED, including regarding the consideration of the forthcoming contribution of Working Group I to the AR5, which will be relevant to both themes of the review.

36. Regarding the approach to the review, most Parties stressed the need for balance between the two themes, in terms of their consideration in parallel, the time allocated to them, the format of activities, and the experts and panellists invited from developed and developing countries; while some Parties were of the view that the next SED meeting should focus on either theme 1 or theme 2.

37. The expert presentations on theme 1 underlined some issues that require further consideration, including:

(a) The trends in observed changes in the physical system, in particular in relation to the atmosphere (e.g. temperature and precipitation), oceans, cryosphere and sea level, including observations relevant to local and regional circumstances, the consideration of which should cover exposure and vulnerability to climate change, the resulting impacts, adaptation options and loss and damage;

(b) The elements to consider when making a value judgement on the adequacy of the 2 °C goal, the use of risk-based framing, and the assessment of the risks of ocean acidification, global and regional sea level rise, and irreversible changes in physical, ecological and human systems, including for specific regions and key sectors and systems. Some Parties stressed that regional assessment should be covered in the review, especially regions that are less studied in the existing climate science literature;

(c) The feasibility of limiting warming, how to treat temperature overshooting and the benefits of achieving the 2 °C goal compared with 'business as usual', as well as current and near-term emission trends and global emission pathways, including target emission levels and budgets for achieving the long-term global goal with high probability.[20]

38. Parties had an initial exchange of views on the adequacy of the long-term global goal for preventing dangerous anthropogenic interference with the climate system and the feasibility of this goal within given socioeconomic and technical constraints. Parties' views differed on whether the feasibility of limiting warming, including in relation to current and near-term emission trends and global emission pathways, should be

---

[19] A summary of the Twitter discussion is available at <http://adoptanegotiator.org/2013/06/05/fcccreview-bringing-science-back-into-the-climate-talks>.

[20] The report of Working Group I will contain emission pathways that are likely to limit warming to below 2 °C or 1.5 °C above pre-industrial levels by 2100.

addressed under theme 1. The effects of the LGTT on helping to streamline global efforts to reduce greenhouse gas emissions and inspire national regional and local initiatives could be another aspect to take into account.

39. The presentations on theme 2 underlined a few issues that require further consideration, including:

(a) The identification of inputs from other relevant processes, referred to in decision 2/CP.17, paragraph 161(b), as one of the sources of information specified in decision 2/CP.17, paragraph 161;

(b) The information base that will help with the assessment of overall progress towards achieving long-term global goal, including information from the forthcoming IPCC AR5 reports, from Parties and from other United Nations agencies and international organizations, and from regional and subregional agencies;

(c) The approach to assess the overall progress towards achieving the long-term global goal, including a consideration of the implementation of the commitments under the Convention. Some Parties were of the view that the implementation of the commitments under the Convention, including of the mitigation commitments of Annex I Parties and of the commitments for provision of financial resources, transfer of technology and capacity-building by Annex II Parties, should be the basis for assessing progress on mitigation and adaptation towards achieving the long-term global goal, while other Parties were of the view that the review should assess the efforts made by all Parties, considering the implementation of the commitments under the Convention only when needed to assess overall progress.

Appendix

Specific information sources suggested for consideration under the structured expert dialogue[1]

1. Assessment and special reports and technical papers of the Intergovernmental Panel on Climate Change:[2]

- International Panel on Climate Change *Special Report on Renewable Energy Sources and Climate Change Mitigation* (2011).

2. Other relevant reports from Parties and processes under the Convention

- Technology needs assessment reports;
- Technical paper on investment and financial flows to address climate change: an update.

3. Other relevant reports from United Nations agencies and other international organizations, including reports on emission projections and technology development, access, transfer and deployment, and reports on gross domestic product, including projections, such as from:

- The Food and Agriculture Organization of the United Nations;
- The World Bank;
- The United Nations Environment Programme;
- The International Arctic Science Committee;
- The International Ocean Carbon Coordination Project;
- The International Human Dimensions Programme on Global Environmental Change;
- The International Energy Agency;[3]
- The Earth System Science Partnership;
- The World Climate Research Programme;
- The International Geosphere–Biosphere Programme;
- The World Economic Forum.[4]

4. Scientific information on the observed impacts of climate change, including from reports coordinated by relevant regional and subregional agencies, such as:

- The South Pacific Regional Environment Programme;
- The Caribbean Community Climate Change Centre;
- The University of the West Indies;
- The University of the South Pacific.

---

[1] This is an initial list of information sources specifically mentioned by Parties during the workshop. For further updates please consult the structured expert dialogue website at <http://unfccc.int/science/workstreams/the_2013-2015_review/items/6998.php>.

[2] Categories 1–4 in this annex reflect the categories of information sources defined in decision 2/CP.17, paragraph 161.

[3] International Energy Agency. 2012. *Energy Technology Perspectives*. Available at <http://www.iea.org/w/bookshop/add.aspx?id=425>.

[4] World Economic Forum. 2013. *Global Risks 2013*. Available at <http://www.marsh.pt/documents/WEF_GlobalRisks_Report_2013.pdf>.

Annex II

Summary report on the second meeting of the structured expert dialogue

I. Introduction

A. Mandate

1. The Conference of the Parties (COP), at COP 18, decided that the structured expert dialogue (SED) should consider on an ongoing basis, throughout the 2013–2015 review, the material from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) as it becomes available, through regular scientific workshops and expert meetings and with the participation of Parties and experts, particularly from the IPCC.[1]

2. The COP, at the same session, also decided that workshops will be open to all Parties and observers, held pre-sessionally, where possible, and organized by the secretariat.[2]

3. In response to these mandates, we sent a message to Parties, on 26 September 2013, indicating our intention to convene the second meeting of the SED (SED 2) to consider the contribution of Working Group I to the Fifth Assessment Report, *Climate Change 2013: The Physical Science* (AR5 WGI), and other information in conjunction with the thirty-ninth sessions of the subsidiary bodies, in Warsaw, Poland; the broad proposed approach to the meeting; and our intention to provide them with an information note outlining that approach.[3] In addition, we invited views on the further work of the SED. The secretariat received four submissions of views from Parties, which we took into account when preparing our approach for SED 2.

B. General objective and approach for the meeting

4. The objectives and goals of SED 2 were to discuss the latest findings, mostly on the basis of AR5 WGI, as they provide a foundation to assess the adequacy of the long-term global goal; to assess the overall progress made so far towards achieving the long-term global goal, as well as the projected progress, including the likelihood of limiting global warming below 2 °C; and to share lessons learned on the effectiveness of the support provided.

5. Accordingly, we organized SED 2 as a fact-finding exchange of views between experts and Parties. IPCC experts presented findings from AR5 WGI and their relevance to both themes of the 2013–2015 review. Representatives of Technology Executive Committee (TEC), Standing Committee on Finance (SCF) and the Global Environment Facility (GEF) presented lessons learned from providing support in technology, finance and capacity-building. A moderated discussion followed addressing guiding questions and questions from all participants.

II. Summary of the proceedings

6. The meeting was held on 12 and13 November 2013 (3–6 p.m. on both days) at the National Stadium in Warsaw, during the thirty-ninth sessions of the subsidiary bodies, and it was open to all Parties and observers.

7. The discussion at the meeting focused on the two themes of the review: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention (theme 1), and overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention (theme

---

[1] Decision 1/CP.18, paragraph 86(a).

[2] Decision 1/CP.18, paragraph 87(a).

[3] Available at <http://unfccc.int/7803.php>.

2). Theme 2 was considered in two parts: global greenhouse gas (GHG) emissions and concentrations; and lessons learned from providing support in technology, finance, and capacity-building.

8. Each session consisted of three parts: (i) presentations by experts (outreach), (ii) group discussions between experts and Parties, and (iii) general discussion with all participants.[4]

9. The meeting was opened and facilitated by Mr. Andreas Fischlin and Mr. Zou Ji, the co-facilitators of the SED. We commenced with a scene-setting presentation made by an IPCC expert on the overarching findings and new approaches of AR5 WGI. The following questions were provided by the co-facilitator to guide the general discussion:

(a) What are the key messages from AR5 WGI relevant for the review?

(b) What does AR5 WGI tell us about the relationship between GHG emissions, atmospheric concentrations and change in the climate system?

(c) How reliable are the projections made using climate models (e.g. equilibrium/transient, timeline of 2100–2300)?

10. Under the first theme of the review, three experts from the IPCC and an expert from the Netherlands Environmental Assessment Agency (PBL), representing the Integrated Assessment Modeling Consortium (IAMC), made presentations. These experts, together with representatives of the European Union, New Zealand, South Africa, the Alliance of Small Island States (AOSIS) and the IPCC secretariat, reflected on the following questions:

(a) What changes has the world observed, and what changes are projected to be observed, that are related to anthropogenic climate change?

(b) Are there any limitations in working only towards a temperature target? Are there any risks associated with this (e.g. misunderstanding uncertainties in climate sensitivities)?

(c) What uncertainties remain? What is the importance of these? Are they significant enough to affect the global response at the policy level?

11. The general discussion was guided by following questions:

(a) What insights exist on the observed and projected changes in the climate system?

(b) What insights exist on the long-term aspects of climate change?

(c) What are the key findings contained in AR5 WGI on the stabilization level of GHG concentrations in the atmosphere that would prevent dangerous anthropogenic interference with the climate system, and what are the associated uncertainties?

(d) How do the above findings relate to the adequacy of the long-term global goal in the context of policymaking under the UNFCCC?

12. Under the first part of the second theme of the review, two experts from the IPCC made presentations. These experts, together with the other two experts from the IPCC, as well as representatives of Brazil, China, European Union, Switzerland and the IPCC secretariat, reflected on the following questions:

(a) What are the uncertainties and the risks associated with specific pathways and how to address them in the context of decision-making? How urgently is action required to move towards and follow emission pathways compatible with the long-term global goal?

(b) How to deal with issues, such as probabilities, overshooting, negative emissions, and irreversible changes?

(c) What information is most necessary to give an accurate picture of global emissions and progress towards the goal?

---

[4] Additional information on SED 2, including the agenda for the meeting and copies of all presentations, is available at <http://unfccc.int/7803.php>.

13. The general discussion under the first part of theme 2 was guided by the following questions:

(a) What does AR5 WGI tell us about the overall progress made so far and the projected progress towards achieving the long-term global goal?

(b) What is the relationship between global emissions and the global temperature rise and how can this be factored into policymaking under the UNFCCC?

14. Under the second part of the second theme of the review, representatives of the TEC, the SCF and the GEF made presentations. These experts, together with representatives of AOSIS, Mexico, Philippines and the Climate Technology Centre and Network (CTCN), reflected on the following questions:

(a) How effective have finance, technology transfer, and capacity-building been in supporting the delivery of mitigation and adaptation outcomes? Which supporting schemes have been successful? Are there some best practice examples of streamlining support to lead to effective mitigation?

(b) What are the best practices/lessons learnt in streamlining support that can lead to effective mitigation of and adaption to climate change? Globally, are there any sectors/gases/policies that are 'low-hanging fruit'?

15. The general discussion under the second part of theme 2 was guided by the following questions:

(a) Which scheme of support has worked and for what reasons?

(b) How can best practices and lessons learned be factored into policymaking under the UNFCCC?

16. At the closing of the meeting, the co-facilitators thanked Parties and experts for their constructive and active participation and for their contribution.

III. Summary of the discussion

A. Setting the scene for the consideration of the contribution of Working Group I to the Fifth Assessment Report

1. Presentations by an expert

17. Mr. Thomas Stocker, a co-chair of Working Group I of the IPCC (WGI), presented the overarching findings and new approaches of AR5 WGI relevant for the review. He identified the following three key messages:[5] observed changes in the climate system, based on multiple lines of evidence, show that the **warming of the climate system is unequivocal** (figure 11); based on the understanding of the climate system and its recent changes, **human influence on the climate system is clear** (figure 12); and projections of future climate change indicate that **limiting climate change will require substantial and sustained reductions of GHG emissions** (figure 13).

18. Regarding the first key message, he noted that the global average surface temperature[6] shows a **warming of 0.85** [0.65–1.06][7] °C over the period 1880–2012 and that the observed warming from 1850–1900 to the **reference period 1986–2005 is 0.61** [0.55–0.67] °C. On the last key message, he underlined that CO_2 emissions from fossil fuels released 375 gigatonnes of carbon (GtC) to the atmosphere from 1750 to 2011, while deforestation released 180 GtC, resulting in cumulative anthropogenic emissions of 555 [470–640] GtC. The period 1870–2011 alone accounts for the amount of 515 [445–585] GtC.

---

[5] See also the headline statements from the AR5 WGI summary for policymakers (SPM), which highlights the overarching conclusions from the SPM in AR5 WGI, at <http://www.ipcc.ch/news_and_events/docs/ar5/ar5_wg1_headlines.pdf>.

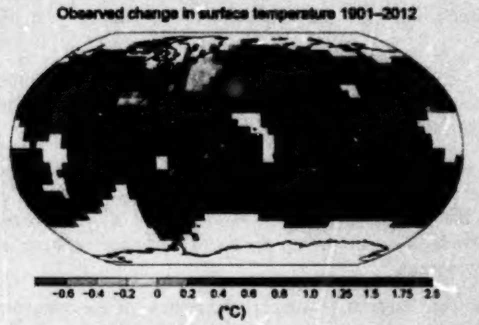
[6] Calculated by a linear trend.

[7] Numbers in brackets give the 90% uncertainty intervals for the best estimate value stated. This interval is expected to have a 90% likelihood of covering the true value that is estimated. These intervals are not necessarily symmetric about the corresponding best estimate.

19. Regarding the relationship between GHG emissions, atmospheric concentrations and change in the climate system, Mr. Stocker noted that the increase in GHG concentrations in the atmosphere and the resulting changes in radiative forcing had an effect on the energy balance of the Earth. As **the total radiative forcing is positive**, it has led to an **uptake of energy in the climate system;** and more than 90 per cent of the energy accumulated between 1971 and 2010 has been **absorbed by the oceans, leading to their warming.** The **largest contribution** to the radiative forcing **is caused by the increase in the atmospheric concentration of CO_2** and these **changes are clearly due to the human influence on the climate system.**

Figure 11

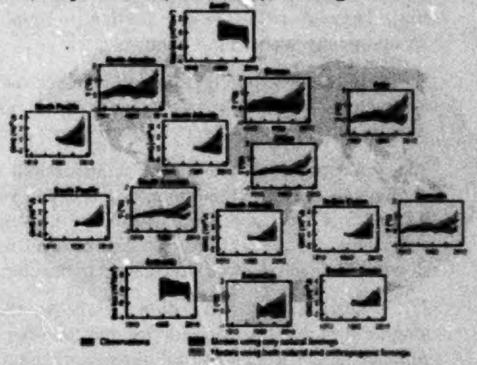
Map of the observed surface temperature change from 1901 to 2012



Source: Summary for policymakers in the contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.1(b).

Figure 12

Comparison of observed and simulated climate change in continental land surface air temperatures (yellow panels), Arctic and Antarctic September sea ice extent (white panels), and upper ocean heat content in the major ocean basins (blue panels) with all forcings (red band) or without anthropogenic, i.e., only natural (blue band), forcings



Source: Summary for policymakers in the contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.6.

20. Mr. Stocker illustrated how Earth system models were used to project changes in the climate system. These models, based on the changes in CO_2 and other drivers, estimate the resulting changes in radiative forcing and temperature, which can be quantified using the transient climate response and equilibrium climate sensitivity. Changes in temperature then create a climate response (e.g. sea level rise) and physical and biogeochemical feedbacks.

21. **Regarding the reliability of the projections** made with climate models, he concluded that, based on a comparison of results from simulations using climate models and observed data, **climate models can reproduce observed surface temperature patterns and trends over many decades not only on the global, but now also on a continental scale** and can therefore be used for projections into the future. He illustrated this with an example of projected changes in average surface temperature and precipitation for 2081–2100 compared to 1986–2005 in the case of the representative concentration pathway (RCP) 2.6 (CO_2 eq concentration reaching 475 ppm by 2100). Changes are much larger for RCP8.5.[8]

22. He also noted **a new quantity** to characterize the climate system, the **transient climate response to cumulative carbon emissions** (TCRE), which is *likely*[9] in the range of 0.8 to 2.5 °C per 1,000 GtC or 3,666 $GtCO_2$.[10] This leads to the important finding that **cumulative emissions of CO_2 will largely determine global**

---

[8] See box SPM.1 on Representative Concentration Pathways (RCPs) and footnote 17 below.

[9] The same conventions for highlighting uncertainty language using italic fonts as adopted by IPCC AR5 (see AR5 WGI SPM, page 4, notably footnotes 1 and 2).

[10] See further explanations on this matter in paragraph 35 below.

mean surface warming by the late twenty-first century and beyond. WGI assessed that the **cumulative total emissions of CO_2 and global mean surface temperature response are approximately linearly related.** Therefore, cumulative emission amounts enable one to easily make a reasonable estimation of the corresponding future temperature response of the Earth for a given amount of carbon emitted to the atmosphere.[11]

2. General discussion

23. A Party asked whether AR5 WGI has provided **a value for the global average temperature change since 1750**[12]. Responding to this question, the expert answered that, due to absence of a data set, WGI could not estimate the warming for the period since 1750 as reliably as the temperature changes for the period 1880–2012.[13]

24. On the issue of climate models, another Party asked about the **reliability of near-term temperature projections**, considering the reduced rate of warming of the last 15 years. The expert answered that the current generation of climate models can and does simulate reduced warming over several years. However, on the decadal timescale it is difficult to predict the precise time point at which such reduced warming will start. He also said that the increase in global mean temperature for a 15-year period starting in 1996 would be almost three times larger than for the one starting in 1998, which illustrates the sensitivity to the starting year of a trend spanning only such a short period.[14]

25. In response to a question on whether WGI focused on **specific temperature targets** in the course of the assessment, the expert clarified that WGI has not focused on any specific temperature targets or scenarios as the work of the IPCC is policy-relevant but not policy-prescriptive.

26. A Party asked for further clarification of the **relationship between increasing GHG emissions and changes in the climate system, especially in regard to the sea level rise corresponding to a TCRE value of 0.8 to 2.5 °C per 1,000 GtC**. The expert answered that it is difficult to capture the impact of sea level rise that is equivalent to a given TCRE, as the sea level responds in a more complex manner than temperature and more slowly (i.e. much delayed) to changes in the climate system.[15]

27. Responding to a question on whether there were **metrics** to support the review of the adequacy of the long-term global goal considering the time-horizon, the expert answered that no single metric can accurately compare all consequences of different emissions, and that the selection of the metric depends on the policy goals and the time horizon of that policy goal.[16]

28. A Party sought clarification on **uncertainties** and their implication for the policy-making process when a wide range of estimates are provided. For example, by 2050, Earth system models for scenarios compatible with RCP2.6 predict annual CO_2 emissions that are lower than 1990 emissions by 14 to 96 per cent.[17] Regarding this point, the expert advised that despite wide ranges the mean or other best estimate value of the model range can nevertheless often be used, in this case IPCC having estimated it to be 50 per cent. He added that all uncertainties in WGI should in general be treated the same way and on both ends of the range.

---

[11] For further details, see paragraph 19 of this report and the AR5 WGI summary for policymakers (SPM) , figure SPM.10.

[12] This somewhat arbitrarily chosen year was used by IPCC to define the pre-industrial period, before 1750, and the industrial period as after 1750.

[13] See paragraph 18 above.

[14] See footnote 5 SPM and paragraph 65.

[15] See further explanations on this matter in paragraph 38.

[16] WGI assessed that no single metric can accurately compare all consequences of different emission pathways. For further details on metrics, see chapter 8, section 8.7 for emission metrics.

[17] SPM, page 27.

B. Theme 1: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention based on the contribution of Working Group I to the Fifth Assessment Report

1. Presentations by experts

29. Mr. Detlef van Vuuren (IAMC/PBL), presented benefits and limitations of the RCPs[18] and compared these scenarios with those from the IPCC *Special Report on Emissions Scenarios* (SRES). He provided four reasons to develop new scenarios for climate assessment: (i) to cover a wider range of GHG concentrations, as SRES only includes scenarios without reference to climate policy and thus provides limited insight into twenty-first century warming and warming commitment; (ii) to widen the set of parameters, such as in reference to land use and pollutants, as climate models have become more complex; (iii) to include scenarios that cover both mitigation and adaptation, which requires collaboration between the IPCC working groups; and (iv) to use more recent insight into trends of scenario drivers.

30. He stressed that **RCPs are the cornerstone of the new process of scenario development,**[19] which was **applied in AR5 to shorten the time between the development of emissions scenarios and their use in impact research**, as well as to address the key information needs of users more effectively. He noted that RCPs nicely span the range of GHG emissions from scenarios in the literature. In terms of radiative forcing, RCP8.5 is comparable to SRES A2/A1FI, RCP6.0 to SRES B2/A1B, and RCP4.5 to SRES B1. There are no SRES scenarios that are comparable to RCP2.6.

31. Regarding scenarios corresponding to **RCP2.6**, he noted that the **decarbonization rate should be around 6 per cent per year after 2030, with an average of 4.5 per cent for 2010–2050.**[20] Assuming that global GHG emissions would peak around 2020, such scenarios would nevertheless require negative emissions by the end of the twenty-first century produced by using bioenergy and carbon dioxide capture and storage (BECCS). It would be **possible to delay the peaking time, although only with stronger emission reductions in the period 2030–2050** (e.g. –5 per cent reduction annually) **and with deeper negative emissions,**[21] to remain in line with RCP2.6. Alternatively, some models show that it is **possible** to be in line with RCP2.6 **without negative emissions, but such scenarios would require immediate and more stringent reductions in global emissions.**

32. Mr. van Vuuren concluded that **RCPs have supplied a strong link between the work of WGI and WGIII;**[22] have allowed for **a set of policy-relevant conclusions to be drawn by the WGI and, at the same time, for WGIII to use results from updated models**; this has allowed for a **strong research focus on the feasibility of the 2 °C goal**. He also said that further research is needed on climate impacts based on RCPs, such as in regard to the assessment of socioeconomic conditions.

33. Mr. Stocker summarized the findings of WGI on the **past, current and future changes in the climate system** (e.g. in temperature, precipitation, ocean acidification, cryosphere, and sea level rise). These findings indicate that it **is *likely* that the global surface temperature will exceed 1.5 °C by the end of the twenty-first century relative to the average of the 1850–1900 period for all scenarios except RCP2.6.**[23] Warming will continue beyond 2100 under all RCP scenarios except RCP2.6, will continue to exhibit interannual-to-decadal

---

[18] RCP8.5: high-range emission scenario (possible development for high population numbers, high fossil/coal use); RCP6.0: medium-range emission scenario (low–medium baseline scenario or high mitigation scenario); RCP4.5: medium-range emission scenario (high mitigation scenario); RCP2.6: low-range mitigation scenario.

[19] See *Towards new scenarios for analysis of emissions, climate change, impacts, and response strategies* published in 2007 at <http://www.ipcc.ch/pdf/supporting-material/expert-meeting-ts-scenarios.pdf>.

[20] See figure on global decarbonization on slide 9 of the presentation by Mr. Van Vuuren, available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_vvuuren13sed2_amended.pdf>.

[21] If sustainable bioenergy is able to provide 150 EJ per year, and all bioenergy is used for BECCS, negative emissions of –10 Gt CO_2 per year are possible.

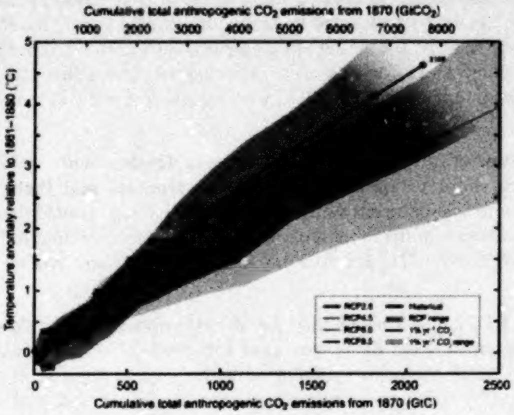
[22] IPCC Working Group III.

[23] See SPM, page 20 and figure SPM.7(a). Note that the temperature increase given in that figure is relative to the reference period 1986–2005, which is estimated to have an average that is 0.61°C above that of the period 1850–1900 (SPM, page 19 and note a to table SPM.2).

variability and will not be regionally uniform. The Northern Hemisphere sea ice extent in September will decrease for all scenarios and a nearly ice-free Arctic Ocean in September is *likely* before the middle of this century for RCP8.5.

Figure 13

Global mean surface temperature increase as a function of cumulative total anthropogenic emissions of CO_2 from various lines of evidence

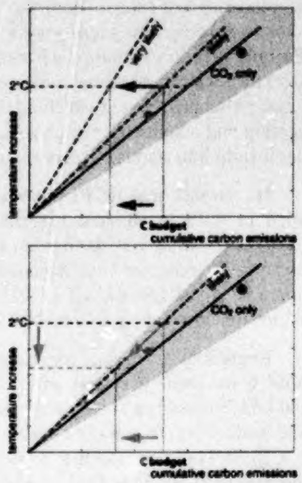


Source: Summary for policymakers in the contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.10.

Abbreviation: RCP = representative concentration pathway.

Figure 14

Controls on the carbon budget



Source: Slides 6 and 7 of the presentation by Mr. Reto Knutti (IPCC), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/7_knutti13sed2.pdf>.

Note: The upper figure shows the reduction in the budget with increasing likelihood to keep warming below 2°C, and the lower the reduction in the budget with lowering the temperature target for the same likelihood for keep warming below 2°C.

34. Regarding global mean sea level rise (GMSLR), Mr. Stocker mentioned that for the first time, WGI was able to make a statement encompassing all the important components that contribute to sea level rise.[24] Regarding ocean acidification in the long term (2081–2100), RCP2.6 shows small changes in pH (from –0.06 to –0.07), while RCP8.5 shows a larger change (from –0.30 to –0.32 pH) by the end of the twenty-first century. Regarding extreme events, it is *very likely* that heatwaves will occur with higher frequency and duration; in case of RCP8.5, e.g. warm days[25] will be over six times more frequent by the end of twenty-first century than during the period 1961–1990.

35. He stated that **cumulative total emissions of CO_2 since 1870 and global mean surface temperature response are approximately linearly related** for all RCPs,[26] and that total cumulative CO_2 emissions since 1870 **must be limited to about 1,000 GtC in order to *likely* limit anthropogenic CO_2-induced warming to below 2 °C compared to the period 1861–1880** (figure 13). When accounting for non-CO_2 forcings, this budget is reduced to about 790 GtC; 515 [445–585] GtC have been emitted by 2011.

36. Regarding long-term aspects, he explained that global temperature will continue to rise by up to 8 °C beyond 2100 in RCP8.5, and that most aspects of climate change will persist for many centuries even if

---

[24] See paragraphs 37–41 below for more information.

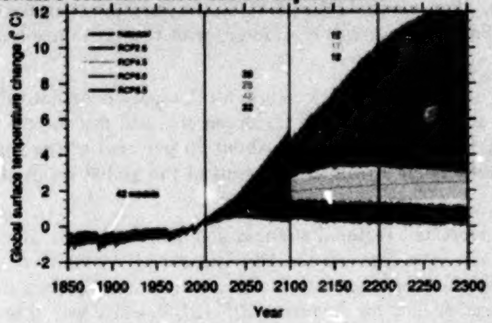
[25] Frequency of days above the 90th percentile of maximum temperature.

[26] See paragraph 22 above.

emissions were stopped at this moment (figure 15). He concluded that these results represent the **substantial multi-century climate change commitment created by past, present and future emissions of CO_2.**

Figure 15

Time series of global annual mean surface air temperature anomalies (relative to 1986–2005) from CMIP5 concentration-driven experiments

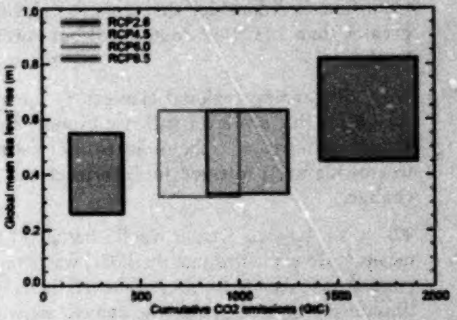


Source: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climat.. Change, figure 12.5.

Abbreviations: CMIP5 = Coupled Model Intercomparison Project Phase 5, RCP = representative concentration pathway.

Figure 16

Relationship between GMSLR, RCPs, and cumulative CO_2 emissions



Source: Slide 9 in the presentation by Mr. Jonathan Gregory (IPCC), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/4_gregory13sed2.pdf>

Note: See also the summary for policymakers in the contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, table SPM.2.

Abbreviations: GMSLR = global mean sea level rise, RCP = representative concentration pathway.

37. Mr. Jonathan Gregory (IPCC) presented findings of WGI on GMSLR. He explained that GMSLR is a result of an increase in the volume of the global ocean as caused by the warming of the ocean (thermal expansion),[27] ice loss from glaciers[28] and ice sheets,[29] and the change of liquid water storage on land (groundwater and reservoirs). For example, the global glacier volume is projected to decrease by 15 to 55 per cent for RCP2.6, and by 35 to 85 per cent for RCP8.5 by the end of the twenty-first century. Regarding observed changes, the rate of GMSLR from 1901 to 1990 was 1.5 [1.3–1.7] mm per year, and 3.2 [2.8 to 3.6] mm per year from 1993 to 2010.

38. It is *very likely* that the average rate of the sea level rise during the twenty-first century will exceed that of the period 1971–2010 under all RCPs. A GMSLR of 0.40 [0.26–0.55] m for RCP2.6 and 0.63 [0.45–0.82] m for RCP8.5 was projected for the period 2081–2100 compared to 1986–2005 (*medium confidence*), and of 0.28–0.61 m for RCP2.6 and 0.52–0.98 m for RCP8.5 by 2100. The collapse of marine-based sectors of the Antarctic ice sheet, if initiated, would add no more than several tenths of a meter during the twenty-first century (*medium confidence*). **Unlike global mean surface warming, the rate of GMSLR depends also on the pathway of CO_2 emissions, not only the total amount of CO_2 emitted, which means reducing emissions earlier rather than later will lead to a lower sea level rise** (figure 16).

39. Commitment to and irreversibility of sea level rise are important aspects, as **stabilizing the global mean surface temperature** (e.g. towards the end of this or during the next century) **will not stabilize the global mean sea level.**[30] It is virtually certain that GMSLR will continue for many centuries beyond 2100. Depending on

---

[27] *High confidence* in projections of thermal expansion and consistency of historical simulations with observations.

[28] *Medium confidence* in projections of glacier mass loss and consistency of historical simulations with observations.

[29] *High confidence* in projections of increasing Greenland surface mass loss and *medium confidence* in projections of increasing Antarctic snow accumulation.

[30] For example, while global surface temperature stabilizes between 2081 and 2100 for RCP2.6, GMSLR continues then still at a rate of 2–7 mm per year.

future emissions, it could eventually reach several meters above pre-industrial levels and possibly include irreversible ice sheet mass loss.

40. **Regarding the projection for 2300**, there is *medium confidence* for a GMSLR lower than 1 m for radiative forcing corresponding to CO_2 concentrations below 500 ppm (about 3 W m^{-2}, similar to RCP2.6), and from 1 to more than 3 m for CO_2 at 700–1,500 ppm (about 5–9 W m^{-2}, as in RCP6.0 or RCP8.5). Sustained warming greater than a certain threshold above the pre-industrial level would lead to a near-complete loss of the Greenland ice sheet (*high confidence*). **That threshold for global mean warming is assessed to be greater than 1 °C** (*low confidence*) **but lower than 4 °C** (*medium confidence*) **with respect to pre-industrial levels.**

41. **Regarding regional changes** by the end of the twenty-first century, Mr. Gregory underlined that it is *very likely* that sea level will rise in more than about 95 per cent of the ocean area and that there will be a significant increase in the occurrence of extreme high sea level events. **About 70 per cent of the coastlines worldwide are projected to experience sea level change within 20 per cent of the global mean sea level change.**

42. Mr. Krishna Kumar Kanikicharla (IPCC) presented **regional changes** and their deviations from global means.[31] He explained that the IPCC was able to use more data sets for AR5 than for AR4,[32] which resulted in more precise data at the regional level, including changes in observed surface temperature and precipitation. He illustrated projected changes in temperature and precipitation for the period 2081–2100, which vary from region to region with various confidence levels. He stressed the **correlation between annual precipitation and changes in extreme events** (maximum five-day precipitation and consecutive dry days for 2081–2100 and RCP8.5), highlighting differences between regions in Latin America and Asia.

43. Mr. Kumar showed how features of regional climate change have been identified and assessed in AR5 WGI through important climate phenomena such as monsoons, El Niño/Southern Oscillation (ENSO) and tropical cyclones and noted that the report provides an Atlas of global and regional climate projections (temperature and precipitation for 3 time horizons and all RCPs) for 35 regions and based on results from 42 global models.

2. General discussion

44. During the **group discussion**, representatives of the European Union, New Zealand, South Arica and AOSIS asked questions and commented on the presentations. In response to a question regarding developments in the **current research on the threshold for critical and significant impacts in the climate system**, in particular regarding what types of **tipping points we should be aware of in order to assess the adequacy of the 2 °C limit**, an expert answered that the findings on the irreversibility of ice sheet mass loss and the time series of ocean acidification have improved.[33,34] Regarding the **predictability of critical thresholds**, another expert said that there has been some progress in identifying these points or whether such points exist for specific components, such as the Greenland ice sheet mass loss or ocean acidification.[35]

45. In response to a question on **scenario development**, in particular regarding consideration of scenarios that were published after 2007, an expert answered that some scenarios published by 2011 were considered in the process of updating and developing RCPs, while scenarios that were developed after 2012 have been considered by WGIII.

---

[31] See chapters 2, 12, 14 and annex I of WGI for regional information.

[32] Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

[33] See paragraphs 34–41 above for details on sea level rise and AR5 WGI, chapter 12, section 12.5, for irreversible changes, chapter 13 for irreversibility of ice sheets and sea level rise.

[34] Impacts to marine ecosystems due to the ocean acidification will be mentioned in the contribution of Working Group II to the Fifth Assessment Report of the IPCC.

[35] For some components critical thresholds are clear from the nature of the process (e.g. melting point of ice in case of the melting of ice sheets, and transition to undersaturation in the case of ocean acidification). See also AR5 WGI Thematic Focus Element TFE.8 on "Climate Targets and Stabilization" in the Technical Summary, notably page 105.

46. A question arose on the **improvement of models for regional precipitation**. The expert answered that models have been improved in this area, for example by increasing their spatial resolution and by improving how they report projections (e.g. hatching patterns show the multi-model mean is small compared to natural internal variability and stippling patterns show that the multi-model mean is large compared to natural internal variability and that at least 90% of the models agree on the sign of change).

47. In response to a question regarding possible limitations due to **working only with a temperature related goal**, an expert explained that such a goal **might not capture all impacts that follow from emissions** and may thus cause other changes in the climate system to be overlooked. For example, the sea level rise beyond 2100 is not scalable with cumulative carbon emissions and leads to a centuries-long commitment, which means that additional measures or stringent limitations on cumulative carbon emissions are necessary to prevent such impacts.[36] He added that meeting **multiple goals would require a more ambitious effort to reduce emissions**.

48. With regard to costs, a Party commented that for Africa, a 1 °C warmer world seems to imply costs within the realm of a 0 °C increase; whereas a 2 °C increase implies costs significantly higher than for a 1 °C increase; and a 3 °C increase is associated with a drastic shift in climate impact and adaptation-related costs, as exceeding critical thresholds results in high-impact climate events.

49. During the **general discussion**, several Parties requested clarification on **underlying assumptions for RCP2.6**[37] and on the consideration of **emissions of short-lived gases**, such as fluorinated gases, particularly hydrofluorocarbons (HFCs). An expert noted that these questions are related to the work of WGIII and elaborated on the technical feasibility[38] and cost estimates for RCP2.6.[39] Another expert said that WGIII is assessing the economic cost, as well as the social and environmental aspects, technology development, and energy profile trajectories. Yet another expert encouraged delegates to participate in the review process of WGII[40] and WGIII draft reports, as many questions were related to those two reports. In reference to the second question, an expert answered that HFCs are also considered in these scenarios.[41]

50. Two questions arose **regarding the 1.5 °C target**: (1) what are the **regional implications of the difference between impacts caused by temperature increases of 1.5 °C and 2 °C**; and (2) which chapters of AR5 WGI present information on impacts from a 1.5 °C increase. Responding to the first question, an expert answered that WGI compared global and regional changes by RCPs rather than in terms of a 1.5 °C versus 2 °C increase. He then said that the projected regional near-term impacts for RCP2.6 may be closest to impacts that could be associated with a 1.5 °C temperature rise. For the second question, the expert answered that the relevant information for the 1.5 °C increase can be found in chapter 11 (near-term projections), chapter 12 (long-term projections), chapter 13 (sea level rise), and chapter 14 (regional issues), as well as in contributions of WGII, WGIII and the Synthesis Report.

51. A Party asked for further clarification on the issue of **multiple goals**, referred in paragraph 47 above, in particular regarding a temperature related goal combined with an ocean acidification or sea level rise goal. The expert answered that, although the issue of multiple goals is relatively new to the scientific community, AR5 WGI provides information for each scenario on the degree of ocean acidification and sea level rise, which also covers relevant temperature related goals that UNFCCC is currently considering. Regarding the sea level rise, another expert reiterated that, in general terms, reducing emissions earlier rather than later would lead to a lower sea level rise.

---

[36] See paragraphs 39 and 40 above.

[37] For example, social and economic aspects such as technical feasibility, cost implications and discount rate, economic growth in developing and developed countries and barriers to technology transfer.

[38] Some models show pathways that are feasible without negative emissions but require immediate emission reductions. Options to reach negative emissions include BECCS, forestation and direct air capture. BECCS seems like a promising option compared to forestation, but requires a trade-off with food production.

[39] For example, costs are about 2 per cent of GDP, a discount rate of 5 per cent is used, and a higher growth rate is used for developing countries than for developed countries.

[40] Working Group II of the Intergovernmental Panel on Climate Change.

[41] See details in annex II of AR5 WGI.

52. In response to a question on **extreme events in mid-latitude regions**, an expert explained the existing complexity of and difficulties in making projections for such extreme events, including wildfire,[42] tornadoes, tropical storms and cyclones.

53. Another Party underlined the importance of **adaptation costs** in policymaking in the context of the long-term global goal. Yet another Party mentioned a paper that analysed the attribution of climate change to human activities using statistical methods rather than models.

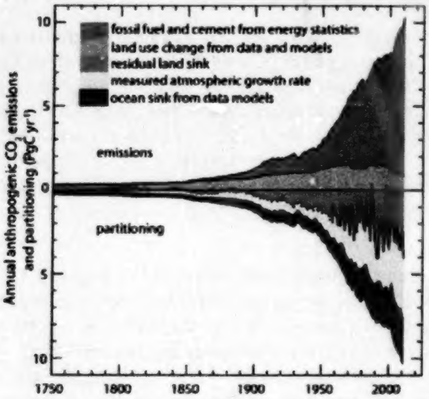
C. Theme 2: overall progress made towards achieving the long-term global goal, including a consideration of the implementation of the commitments under the Convention

1. Presentations by experts on trends in global greenhouse gas emissions and concentrations

54. The **first part of theme 2** focused on global GHG emissions and concentrations. Ms. Corinne Le Quéré (IPCC) presented past, current and projected changes of global GHG emissions and concentrations. In 2011, the concentrations of GHGs in the atmosphere reached 390.5 ppm for CO_2 (40 per cent increase compared to the pre-industrial period); 1,803 ppb for methane (CH_4) (150 per cent increase) and 324.2 ppb for N_2O (20 per cent increase). WGI concluded that **the largest contribution to total radiative forcing is caused by the increase in atmospheric CO_2.**

Figure 17

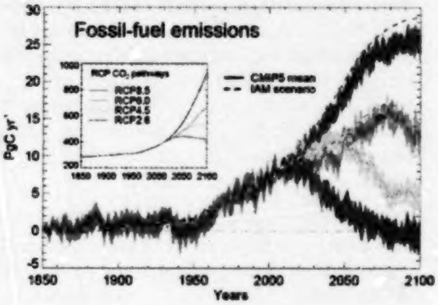
Annual anthropogenic CO_2 emissions and their partitioning among the atmosphere, land and ocean from 1750 to 2011



Source: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change , Technical Summary, figure TS.4

Figure 18

Compatible fossil fuel emissions simulated by the CMIP5 ESM models for the 4 RCP scenarios



Source: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 6.25.

Abbreviations: CMIP5 = Coupled Model Intercomparison Project Phase 5, ESM = Earth System Model, IAM = Integrated Assessment Modeling, RCP = representative concentration pathway.

55. Regarding historical emissions from 1750 to 2011, **CO_2 emissions from fossil fuel combustion and cement production** have released 375 [345–405] GtC into the atmosphere (some 70 per cent of total cumulative emissions), while deforestation and other land-use change are estimated to have released 180 [100–260] GtC (some 30 per cent of total cumulative emissions).[43] Some 155 [125–185] GtC have been taken up by the ocean

---

[42] Projection of wildfire or heatwaves need projections of the quantity of soil moisture, but the global models used for the former have not captured the latter.

[43] Land-use change emissions are subject to large uncertainties and can be negative.

and 160 [70–250] GtC have accumulated in residual land sinks (figure 17). **Recently**, over the period 2002 to 2011, **emissions from fossil fuel combustion and cement production amounted to 90 per cent of total CO_2 emissions** while the remaining 10 per cent during that period were due to land-use change.

56. She explained that Earth system models[44] showed that land and ocean CO_2 sinks continue to increase when the models simulated increasing atmospheric CO_2 only, while the opposite response was observed when the models simulated climate change only. The latter showed that **climate change affects the carbon cycle processes in a way that will exacerbate the increase of CO_2 in the atmosphere** (*high confidence*).

57. After presenting the cumulative emissions for all RCP scenarios from 2012 to 2100, Ms. Le Quéré said that future emissions following RCP2.6 are on average 50 [14–96] per cent lower by 2050 than 1990 emissions (figure 18), and about half the models indicate emissions below zero by 2100. The **cumulative future CO_2 emissions that are compatible with RCP2.6** (270 [140–410] GtC from 2012 to 2100) **are less than half the historical emissions** (555 [470–640] GtC from 1750 to 2011).

58. Mr. Reto Knutti (IPCC) presented the relationship between global CO_2 emissions and the global temperature rise. He stressed that a substantial multi-century climate change commitment was created by past, present and future emissions of CO_2. **Stable CO_2 concentration will result in further warming over centuries, and even if CO_2 emissions reach zero,** about **15–40 per cent of the emitted carbon will remain in the atmosphere for longer than 1,000 years** depending on the scenario. However, most models show no or very little commitment to further surface warming from past CO_2 emissions once emissions should stop or become negative.

59. He further stated that cumulative emissions of CO_2 will largely determine global mean surface warming by the late twenty-first century and beyond. WGI found that warming is largely independent of the emission pathway and that only the total amount emitted matters. Hence, every ton of CO_2 causes about the same amount of warming, no matter when and where it is emitted. Therefore, **any temperature limit implies a maximum amount of cumulative CO_2 emissions compatible with that limit. Halting the global mean temperature rise at any level will require near zero carbon emissions at some point in the future.**

60. The total cumulative carbon budget (CO_2 only) corresponding to the likelihood of 90, 66, 50, 33 and 10 per cent of the temperature increase since 1861–1880 staying under 2 °C are 730, 1,000, 1,212, 1,567 and 3,567 GtC, respectively[45]. In the case of a 1.5 °C increase, this budget is estimated at 548, 750, 909, 1,176, and 2,675 GtC, respectively (figure 14). Consideration of non-CO_2 forcing implies a lower budget. For example, the **upper amount is reduced from 1,000 GtC to about 790 GtC when accounting for non-CO_2 forcing as in RCP2.6** (probability greater than 66 per cent of staying under 2 °C); 515 GtC have already been emitted from this budget by 2011. He said **the long-term global goal could be seen as a threshold that must not be exceeded or as an eventual target after overshooting** and noted that some temperature related goals are very difficult to reach if defined as a threshold, but can be reached eventually after overshooting.

2. General discussion

61. During the **group discussion**, Brazil, China, the European Union and Switzerland asked questions and commented on the presentations. Some questions arose on **emissions from fossil fuels and land-use change**, including on their geographic distribution, the means to secure land sinks so as to continue the absorption of carbon, and the **relationship between emissions and the capacity of land and ocean sinks**. The experts explained that there is solid data for the geographical distribution of emissions from fossil fuel, but that for land use there was no agreement among experts regarding the distribution by region, even for recent decades. They also explained that, if sink capacity is to be secured, deforestation and changes in the climate should be limited. There is a relatively linear trend between emissions and the response of land and ocean sinks except for cases of higher emissions. The experts further said that, **while the quantification of changes in land and ocean sinks for high emission scenarios is difficult, the direction is clear: such scenarios will weaken the capacity of sinks.**

---

[44] Climate models that take into account carbon cycle processes. This includes uncertainties in carbon climate feedbacks, except feedbacks from frozen permafrost, from wetlands with a warmer climate and from marine hydrates.

[45] All numbers given here are estimates derived using the same method as described in AR5 WGI, Chapter 12, page 1113.

62. A Party asked about the **relationship between emissions and impacts such as ocean acidification, sea level rise or food production**. The experts answered that this relationship is not linear, and that different goals may require different carbon budgets. He also explained that a goal linked to food production may require the assessment of additional components that go beyond physical changes in the climate system.

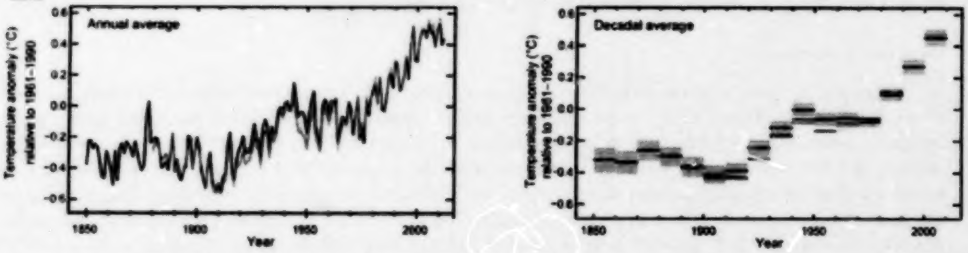
63. Responding to Mr. Knutti's presentation, a Party pointed out the importance of the **emission pathway and the rate of changes in the climate system**, as different pathways may show different types and rates of impacts. Therefore, an important message is that **global emissions have to peak and decline in the near future to reach a low-emission pathway and limit warming**. The expert responded that the rate of climate change and the exact emission pathway, in contrast to global mean temperature, may indeed matter for some impacts such as sea level rise.[46]

64. A Party asked a question about the **uncertainty ranges** and how they would impact policymaking, in particular in regard to the fact that such ranges translate into differences in future budgets equivalent to historical cumulative emissions. The Party noted that the practical meaning of such ranges is important and that further efforts are needed to reduce the uncertainties.[47] A different Party asked about the uncertainty range associated with the 50 per cent reduction by 2050 required by RCP2.6. He noted that the uncertainty comes in at different timescale, for example for concentrations and temperatures, and there is much less uncertainty for concentrations than for temperature profiles in going forward. It stressed that **uncertainty should be considered in risk management and that higher uncertainties will mean a lower carbon budget**, for example. The expert answered that the range of values represents the minimum to maximum values provided by all the models and that it is not very large if standard deviation is considered. He reiterated the need to focus on the total budget rather than total emissions at a given point in time, agreed that higher uncertainties will mean a lower carbon budget[48] and noted that the question of choosing a specific probability of keeping temperature below a given limit is not a scientific question nor a scientific uncertainty but is to be addressed as part of a value judgment.

65. Another Party was of the view that the **progress towards the long-term global goal** should be assessed **in terms of temperature.** He suggested that the goal should be broken down into partial targets that would be assessed every 10 years,[49] and asked about the feasibility of developing a methodology for this purpose. In response, an expert noted that adopting such an approach would be difficult, owing to the difficulties associated with the decadal predictability of temperatures. He stressed that there are periods with less warming (figure 19), and that short-term trends could lead to wrong conclusions when compared with long-term trends.[50] Instead, he pointed out, the goal should be revised based on emissions, which are well documented and for which we have a clear understanding of what they mean in terms of long-term commitments.

Figure 19

Observed global mean combined land and ocean surface temperature from 1850 to 2012, from three data sets



Source: Summary for policymakers in the contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.1(a).

---

[46] See figure 58 and 61 above.

[47] See paragraph 28 above.

[48] See figure 58 and 59 above.

[49] The scientific community would assess the temperature targets, while policymakers would assess mitigation actions that combat temperature increases.

[50] See paragraph 24 above.

66. During the **general discussion**, a Party asked about the assessment of **risk of carbon cycle feedbacks** associated with different degrees of warming, especially **regarding whether overshooting scenarios would increase the risk of these feedbacks**; about which is a safer global warming limit for reducing these risks (1.5 °C or 2 °C); and about whether high probability emission pathways to limit warming to 1.5 °C would reduce the risk of overshoots and carbon cycle feedbacks. An expert answered that higher emission scenarios have broader feedbacks. She also mentioned that keeping the temperature rise below 1.5 °C could also help control carbon cycle feedbacks, and that smaller temperature changes will lead to smaller feedbacks.

67. A different Party asked two questions regarding the **relationship between the timescale and impacts**: (1) at what point do the impacts of a 2 °C rise matter; (2) is the timescale the same for various physical changes in the climate system, such as precipitation, ocean acidification or sea level rise? An expert answered the first question by saying that the timescale of the impacts will depend on the type of impacts. For example, warming will immediately impact precipitation or extreme weather, whereas changes in the Greenland ice sheet melting would take considerably much longer to occur and a few years would not matter.[51] In general, the timescales for emitting carbon might also apply to those for taking carbon out of the atmosphere (e.g., if we overshoot for 50 years we might stay above the target for 50 years).

68. In response to the second question, the expert said that there is no linear feedback in the case of ocean acidification, as the upper and deeper ocean have different acidification profiles. Regarding changes in extreme events in terms of early versus late reduction, the expert answered that both global and local temperature matter for extreme events, and that thus the timing of reductions does not affect the timing of the events. Regarding the relationship between timescale and impacts he said that the reduction of emissions short-lived GHGs will show an effect immediately (e.g., the effect of reducing emissions of a short lived GHG in 2050 is seen in 2050 not in 2100). However, another expert added that reductions of short-lived GHGs emissions ought to be seen in addition to those of long-lived GHGs (particularly CO_2) to effectively manage a long-term goal.

69. Regarding a question on a **committed temperature rise** for RCP2.6, an expert answered that the temperature rise that is projected under RCP2.6 is *likely* below 2 °C in 2100 relative to the 1850 level (the mean response of models is about 1.6 °C). As regards commitments, he said that there is no warming commitment from past emissions in the physical climate system[52] that will cause further warming and that if we stop emissions today entirely, there will be no further warming. Essentially, the commitment to future warming is in future emissions. A siable concentration, however, will result in further warming.

70. Another Party asked whether there is coordination between WGI and WGII on reflecting the impact of a committed temperature rise on the cost of adaptation, which will be assessed by WGII. The expert answered that impacts and adaptation will be discussed in the WGII report for the same scenarios using the projections from the climate models from AR5 WGI.

71. Responding to a question regarding the **recent increase of CH_4 emissions from natural wetlands**, an expert said that while natural variability has caused a slowdown in recent warming, there are limited data available to support attributing the increase in CH_4 to a particular process. Only the results from one model linked this increase to changes in rainfall (not a systematic change) and to changes in fossil fuel emissions.

72. With regard to the **commitment from carbon infrastructure** that has already been built, an expert explained that this matter is addressed mainly by WGIII and that the question is if that infrastructure will be phased out at the end of its lifecycle or earlier.

73. In response to a question regarding the **potential of land sinks** in RCPs by 2050, an expert explained that the RCPs have clear pre-defined emission pathways for the twenty-first century. On the other hand, in the context of the discussion on uncertainty, the earth system models used by WGI show changes in sources of terrestrial biosphere sinks based on assumptions about vegetation and the climate change, in particular in precipitation.

---

[51] According to IPCC AR5 a global warming higher than a certain threshold value above preindustrial levels sustained over a millennium or more would lead to the near-complete loss of the Greenland ice sheet, causing a global mean sea level rise of up to 7 m. See AR5 WGI SPM page 29 and Executive Summary of chapter 13.

[52] Which is only true for global mean temperature but not for other responses of the climate system such as sea level rise. See also paragraphs 39, 58 and 63 above.

3. Presentations by experts on lessons learned from support in technology, finance and capacity-building

74. **Second part of theme 2** focused on lessons learned from support in technology, finance and capacity-building. Mr. Antonio Pflüger, the Chair of the TEC, outlined the **key milestones in the technology process under the Convention**, culminating with the establishment in 2010 of the Technology Mechanism comprising the TEC, which provides policy recommendations and briefs to the COP and to stakeholders, and the CTCN, which aims to enhance the effectiveness of support for delivering mitigation and adaptation action and responds to developing country Parties' requests. An important component of the technology transfer framework is the technology needs assessments (TNAs), a country-driven process aiming to identify priorities for mitigation and adaptation technologies. The second generation of TNA reports[53] provides information on prioritized sectors and technologies, barriers to and enablers for technology development and transfer, technology action plans, project ideas, estimated budgets for the short and the long term and possible linkages with other processes under the Convention, such as nationally appropriate mitigation actions (NAMAs) and national allocation plans (NAPs). However, the issue of measuring and monitoring the effectiveness of technology development and transfer may need to be further considered.

75. The TEC produced two briefs related to TNAs in 2013 that summarized the **lessons learned from TNAs**,[54] including the following: TNAs are rich sources of information on the technology needs of developing countries; financial and economic barriers are critical and they should be referred to by all financial entities under and outside the Convention; high-level governmental support and coordination of the TNA process is essential; TNAs should evaluate prioritized technologies that may be considered in NAPs and NAMAs; Parties, when preparing NAMAs and NAPs, should ensure coherence with the TNA findings; and the TNA process effectively helps Parties and relevant stakeholders to implement mitigation and adaptation projects.

76. Ms. Diann Black-Layne, the Chair of the SCF, introduced the general mandates of the **SCF** and provided **information relevant to the review**. She said that the questions are how much funding has been provided to place us on track for a 2 °C world and if this support can be further strengthened to meet a more ambitious target. In response to the first question, she said that the amount of funds being currently allocated to climate finance is inadequate to meet the 2 °C target and that some projections indicate that the current level of spending on "brown" technologies will continue to grow faster than that on renewable technologies.

77. Regarding the second question, she stressed that the **SCF will** be in a position to **assess the overall global financial needs for meeting the goals** agreed upon by the Convention and can present this information at a future SED meeting, in 2015 or beyond. Regarding adaptation, she emphasized that although spending on adaptation has increased, the current focus remains on mitigation despite efforts to place more weight on adaptation.

78. Mr. Robert Dixon (GEF) outlined the role of the **GEF** in financing clean energy and technology investments, adaptation and enabling activities. In terms of **lessons learned**, he highlighted the importance of **mainstreaming private sector engagement** in climate financing, **market transformation** through risk reduction in capital-intensive investing, more efforts to enhance **enabling environments** through capacity-building and technical assistance; and strengthening efforts to build the necessary **support infrastructure and policy frameworks** to further scale-up technology investment and archive transformational impact. He also stressed that **capacity-building** activities should be integrated with adaptation efforts, not be stand-alone activities.

79. In the future, the GEF will continue to invest in financing mechanisms and incentives to bring in the private sector; developing local know-how and intellectual capital through technical assistance and capacity-building; supporting countries in their transition to long-term adaptation, in addition to continuing support for urgent and immediate adaptation needs; encouraging a more strategic approach to multifocal area projects and programmes; and accelerating the demonstration and deployment of innovative adaptation and mitigation technologies and associated business models.

---

[53] See the third synthesis report on technology needs identified by Parties not included in Annex I to the Convention at <http://unfccc.int/resource/docs/2013/sbsta/eng/inf07.pdf>.

[54] Available at <http://unfccc.int/ttclear/pages/tec_home.html>.

4. Discussions (part two)

80. During the **group discussion**, representatives of AOSIS, Mexico and Philippines asked questions and provided comments. **On technology**, their questions included whether technology transfer is shifting the industrial or technology infrastructure in developing countries towards low emission pathways, how the CTCN would evaluate the technology process of the last 20 years, what the timeline for moving from planning technology transfer to starting to measure its achievements and impacts is, and when we will know the technology needs for supporting mitigation and adaptation action.

81. A Party commented that WGI findings are clearly assuming that increased funding, technology transfer and capacity development are required to meet the 2 °C or 1.5 °C goal. On the subject of low-hanging fruit, another Party was of the view that delaying action locks in the high carbon infrastructure, and that it will be more difficult to reduce emissions in the future.

82. Responding to these questions, the TEC expert said that the evaluation of the technology transfer process over the last 20 year should be seen in the light of the mandates provided by the technology transfer frameworks that were developed during that time. He underlined that in the past two years **the technology mechanism has undergone a fundamental change** and is now moving fast, but that more work is needed to make it fully operational. A key message from the TEC is that factors other than funding are equally important for a successful transfer of technologies, including identifying the right partners in the recipient country, establishing good national coordination between institutions working on TNAs, NAMAs, and NAPs, and having an adequate research and development programme.

83. The CTCN expert responded that the technology mechanism created by Parties captures the full spectrum of technology transfer, diffusion and adoption. The CTCN, hosted by the United Nations Environment Programme (UNEP), will be fully operational soon and will start receiving requests from Parties through their national designated entities.[55] It will identify, based on TNAs, barriers to technology transfer and provide guidance on how to mitigate them. The impact of projects depends on how the recipients of the information and the technology system will implement the recommendations from the CTCN, including on changing policies and regulatory structures and on developing the capacity and skills needed. The CTCN will ask developing countries receiving assistance for feedback on its services and will adjust its activities accordingly.

84. The **questions on climate finance** included how climate finance needs compare to what has been provided,[56] if there is scope for expansion and possible improvement of the effectiveness of the Adaptation Fund and application of its best practices to the work of the Green Climate Fund and the TEC, when SCF will know the financial needs for the period ending in 2050 by sector and region and how these needs will be structured and communicated, and what the rate of co-investment is that will catalyse funding of climate projects and will keep the right appetite for risk.

85. A Party commented that funding for adaptation will be significantly lower for meeting the 1.5 °C rather than the 2 °C goal. Another Party was of the view that SCF should work on the long-term finance pathways needed to achieve the long-term global goal and the modalities for achieving this. Yet other Parties were of the view that the Adaptation Fund should be seen as the benchmark for adaptation finance, because it provides access to finance to national and regional implementation entities and that most support schemes worked when cross-cutting issues were considered (e.g. technical, economic and market potential).

86. Regarding the **support schemes that worked**, an expert gave an example of an oil-importing agreement with Caribbean States that allowed for partial payment combined with a loan at favourable rates, with the condition that the savings generated are invested in poverty eradication and renewable energy programmes. She said that extreme weather events and market signals generated by the price of oil should be the main drivers for climate finance and technology, but that markets failed to react to these drivers. Therefore, the new agreement

---

[55] Some 30 countries identified such entities.

[56] In the context of this question, a Party provided information on the amount of climate finance required from various sources, as well as on finance provided, as reported in the fifth national communications of Parties included in Annex I to the Convention. Another Party recalled that the commitment made by developing countries to mobilize short-term finance was not reported in those national communications.

should look at the market failures in each country and try to address them. The SCF should have also a role in this.

87. She also suggested that the CTCN should develop **a registry of proven technologies** and thus contribute to reducing the risk inherent in investing in climate technologies. She also said that the Adaptation Fund, which receives funding through the carbon market, will eventually dry up due to market failures. However, the Fund has proven to be one of the most efficient funds because the transaction costs were reduced by providing direct access to funds.

88. During the **general discussion**, a Party underlined that in some countries domestic carbon emissions are at their lowest level in two decades despite economic growth and noted that the UNEP Emissions Gap Report also showed **signs of a beginning of the decoupling of emissions from economic growth**. He talked about international efforts made outside the UNFCCC process to reduce emissions, including by reducing international financing for coal plans and cutting fossil fuel subsidies. Responding to this comment, the GEF expert noted that supporting fuel switching is one of the priorities of the GEF action plan.

89. Another Party underlined that it is making tremendous efforts to support mitigation action domestically and internationally, announced that they surpassed their pledged funding for fast-start finance, and that it is committed on scaling up the mobilization of climate finance in the context of meaningful mitigation action and transparency of implementation. Its GHG emissions in 2011 were reduced by 18 per cent compared to 1990, while the region's gross domestic product grew by 45 per cent in the same period.

90. Yet another Party commented that many developing countries have undertaken TNAs but that the technology transfer is not happening. Responding to this comment, the TEC expert said that countries need to follow up and implement the institutional, policy, regulatory and technology road map identified in TNAs. The TEC and the CTCN were created to support the countries' efforts on this matter.

91. Regarding a question on providing an example of when **intellectual property rights** prevented technology transfer and how this will be addressed, the TEC expert answered that this matter should not be addressed in the UNFCCC process but under the auspices of the World Trade Organization as part of trade-related aspects of intellectual property rights. He said that, in general, intellectual property rights facilitate and catalyse, not inhibit, the development of technologies. He also added that developing countries identified in their TNAs the lack of finance, policy and regulatory structures, as well as gaps in knowledge and human capacities, as key barriers to technology transfer. Intellectual property rights were not among these five key barriers, he added, and it is unfortunate that this issue has become a distraction from accelerating technology transfer. This point was echoed by the GEF expert.

92. One Party asked about the **role of the private sector in investing in adaptation,** from a business risk perspective, and about how Parties could **better engage subnational actors** to scale up action on mitigation and increase resilience, particularly in the pre-2020 period. The TEC expert answered that there is a trend of decentralization of the economic and political power to the subnational level, increasing the importance and role of subnational level actors as they become responsible for mitigation and adaptation projects. He also noted the importance of integrating national programmes with action by states and cities. For example, he noted that there are many corporations looking at making cities more resilient to climate change. He also talked about spatial integration as an additional dimension to sectoral integration and about improving vertical communications from local to city, state and national levels. The GEF expert noted that working with cities and local governments had been successful in the past, that the GEF would like to build on this good experience in the future and that mainstreaming adaptation in national planning was an important step forward.

93. Regarding a question on how the GEF has managed to implement a large number of projects at USD 1/tonne CO_2, the expert responded that the GEF has indeed financed many cost-effective clean energy and technology investments, which is part of GEF's role and design.

94. Regarding the question on **leveraging private sector investment** and the existence of **guidelines on the bankability of mitigation and adaptation projects**, the GEF expert said that such resources exist. He provided an example regarding the concentrating of solar power, where the GEF took on higher risks 15 years ago by investing in big technology projects in developing countries, and noted that this made possible the implementation of those projects, which are now in operation. In general, the GEF is looking at technologies that are at the end of the research and development pipeline and might be attractive in the future, such as smart grids,

fuel switching and carbon dioxide capture and storage, as well as at new financial instruments and investments that integrate multiple benefits.

95. In response to a question, the SCF expert explained some of the **difficulties in defining what constitutes new and additional financing**, including in defining what a low-carbon technology is and what sort of role the TEC and the CTCN may play in the future in this matter, in deciding whether or not to count in this category those funds that are leveraged by a project, as well as in estimating the flows of funds countries may encounter delay or hurdles in receiving disbursed funds.

D. Reflections on second meeting of the structured expert dialogue

96. It is our perception that the discussions in Warsaw were very productive and informative and that they supported Parties in internalizing the key findings of AR5 WGI relevant to both themes of the review. SED 2 saw you engaging in a constructive and productive manner in all discussions with the IPCC and other experts.

97. Parties had a rich exchange of views with experts on the adequacy of the long-term global goal and the overall progress made so far towards achieving the long-term global goal, including the likelihood of meeting and maintaining the goal, on the basis of AR5 WGI. They also heard from experts some of the lessons learned on the effectiveness of technology and finance support. We congratulate you and the experts on this successful meeting and encourage you to maintain this positive spirit.

98. The presentations and discussions underlined some particular issues that might require consideration at the third meeting of the SED on the basis of the forthcoming contributions of WGII and WGIII to AR5, including:

(a) Risk management, including the relationship between risk and overshooting of the goal, geographical distribution of risks given regional differences in impacts and in economical or other costs of adaptation for various levels of warming;

(b) Underlying assumptions, feasibility and cost of impacts, mitigation, and adaptation in terms of RCPs and other scenarios considered by the IPCC, as well as temporal aspects of emission pathways while considering aspects such as short-lived GHGs and commitments in carbon infrastructure.

99. We believe that our approach to the SED meeting worked well, and we will continue to consider the two themes of the review in parallel, maintaining the balance between them in terms of the time allocated to them, the format of activities, and the experts and panelists invited from developed and developing countries. We also believe that an adequate amount of time was allocated to our meeting and we aim to make similar arrangements for the consideration of the contributions of WGII and WGIII to AR5.

Annex III

Summary report on the third meeting of the structured expert dialogue

I. Introduction

A. Mandate

1. The Conference of the Parties (COP), at its eighteenth session, decided that the structured expert dialogue (SED) should consider on an ongoing basis, throughout the 2013–2015 review, the material from the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) as it becomes available, through regular scientific workshops and expert meetings, and with the participation of Parties and experts, particularly from the IPCC.[1] The contribution of Working Group II to the AR5[2] (AR5 WGII) and the contribution of the Working Group III to the AR5[3] (AR5 WGIII) were approved and accepted by the IPCC in March and April 2014, respectively.

2. At their thirty-ninth sessions, the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI) requested us, the co-facilitators of the SED, to organize its meetings in 2014 in conjunction with the fortieth and forty-first sessions of the subsidiary bodies.

3. In response to the above-mentioned mandate, we convened the third meeting of the SED (SED 3) during the fortieth sessions of the subsidiary bodies, to make a contribution to the assessment of the adequacy of the long-term global goal and the overall progress made towards achieving it, to the extent possible, on the basis of AR5 WGII and WGIII. Prior to SED 3, we provided Parties with an information note outlining our approach to the organization of the meeting.[4]

B. General objective and approach for the meeting

4. The goal of SED 3 was to make a contribution to the assessment of the adequacy of the long-term global goal and the overall progress made towards achieving it, to the extent possible, on the basis of AR5 WGII and WGIII.

5. Accordingly, we organized SED 3 in a similar manner to previous SED meetings as a fact-finding exchange of views between experts and Parties. IPCC experts presented findings from AR5 WGII and WGIII and highlighted their relevance to both themes of the 2013–2015 review (see para. 8 below). These presentations were followed by a moderated discussion guided by questions prepared by the co-facilitators[5] based on questions provided by Parties through their submissions,[6] questions from participants, and additional questions provided by some Parties before each part of the meeting.

---

[1] Decision 1/CP.18, paragraph 86(a).

[2] *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Available at <http://www.ipcc.ch/report/ar5/wg2>.

[3] *Climate Change 2014: Mitigation of Climate Change*. Available at <http://www.ipcc.ch/report/ar5/wg3>.

[4] Available at <http://unfccc.int/8622.php>.

[5] For the list of questions, please see the SED 3 agenda, available at <http://unfccc.int/8622.php>.

[6] SBSTA 39 and SBI 39 agreed to continue consideration of the volumes of IPCC AR5 as they become available; other inputs as listed in decision 2/CP.17, paragraph 161; questions put forward by Parties to ensure a balanced consideration of these inputs; and the views of Parties on both themes of the 2013–2015 review, in accordance with decision 1/CP.18, paragraph 88, and requested Parties to submit their views on the future work of the SED, including the further use of different sources of information (FCCC/SBSTA/2013/5, paragraphs 134–135 and FCCC/SBI/2013/20, paragraphs 168–169). The submissions from Parties are available at <http://unfccc.int/science/workstreams/the_2013-2015_review/items/7590.php>.

II. Summary of the proceedings

6. SED 3 consisted of four parts and was held on 6–8 June 2014 at the Maritim Hotel in Bonn, Germany, during the fortieth sessions of the subsidiary bodies, and was open to all Parties and observers. Part 1 was held on Friday, 6 June (4–7 p.m.), part 2 was held on Saturday, 7 June (10 a.m.–1 p.m.) and parts 3 and 4 were held on Sunday, 8 June (10 a.m.–1 p.m. and 3–6 p.m., respectively).

7. The meeting was chaired and moderated by us, the co-facilitators. Christiana Figueres, Executive Secretary of the UNFCCC secretariat, opened the meeting, underlining that the purpose of the SED is to build a bridge between science and policy. While recognizing that science is always a few steps ahead of policy, she stressed that the AR5 highlights the urgent need for policy to "catch up", both in the short term to bend the emissions curve to stay on the path to limit global warming below 2 °C, and in the long term. She added that the 2015 agreement[7] should therefore provide the basis for reaching a level where the same amount of greenhouse gases (GHGs) are absorbed as are emitted.

8. The discussion at the meeting focused on the two themes of the review: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention (theme 1), and overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention (theme 2).

9. With respect to AR5 WGII, the topics addressed included: the observed impacts and projected risks associated with various levels of warming, including warming to 2 °C or 1.5 °C; human interference with the climate system; the link between socioeconomic pathways and climate change risks; adaptation options, needs, opportunities and associated costs; climate-resilient pathways; and the link between adaptation, mitigation and sustainable development.

10. As regards AR5 WGIII, the topics addressed included: transformation pathways and limiting warming to 2 °C or 1.5 °C; sectoral and cross-sectoral mitigation pathways; trends in the stocks and flows of GHG emissions and their drivers; international cooperation on mitigation; policy, socioeconomic, equity and ethical aspects of climate change; and cross-cutting mitigation investment and finance issues.

11. In preparing the questions that guided the discussions in each part of SED 3, we took into consideration the above-mentioned questions submitted by Parties, our experience with the first and second meetings of the SED, as well as overarching issues such as: the requirements and limitations associated with the long-term goal to limit the increase in the global average temperature below a specific level, such as 2 °C or 1.5 °C above pre-industrial levels;[8] the costs and benefits of limiting warming to a given level; the level of unacceptable global warming; and the consequences of delaying action. The mandate of the 2013–2015 review requests the SED to address such issues; SED 3 enabled us to obtain the scientific information relevant to the quest for reliable answers to such questions.

12. **Part 1** of the meeting opened with a scene-setting presentation made by an IPCC expert on the overarching findings and new approaches of AR5 WGII that are relevant to both themes of the 2013–2015 review. The presentation was followed by a discussion guided by questions. Subsequently, presentations on theme 1 of the review focused on the past and current impacts of, as well as the projected risks posed by, climate change from global and regional perspectives with a view to assessing the adequacy of the long-term global goal using inputs from AR5 WGII, and outlined the climate risk management framework and the mapping of the so-called 'solution space'.[9]

13. **Part 2** started with presentations on impacts, adaptation and vulnerability issues relevant to theme 2 of the 2013–2015 review and explored: the link between socioeconomic pathways and the risks posed by climate change; adaptation options, needs, opportunities and associated costs; climate-resilient pathways and the relationship between adaptation, mitigation, and sustainable development in the context of assessing progress

---

[7] The COP, by decision 1/CP.17, launched a process to develop an agreement under the Convention applicable to all Parties, to be adopted at COP 21 in 2015 and to come into effect and be implemented from 2020.

[8] Decision 1/CP.16, paragraph 4.

[9] See figure SPM.8 in the summary for policymakers in AR5 WGII, available at <http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf>.

made towards achieving the long-term global goal. The presentations were followed by a substantive discussion guided by questions.

14. **Part** 3 of the meeting opened with a scene-setting presentation by an IPCC expert on the overarching findings and new approaches of AR5 WGIII that are relevant to both themes of the 2013–2015 review. The presentation was followed by a discussion guided by questions. Subsequent presentations on theme 1 of the review focused on transformation pathways and limiting warming below 2 °C or 1.5 °C, including the likelihood of limiting global warming at those levels and the urgency of the action required to move towards such pathways; sectoral and cross-sectoral mitigation pathways; mitigation potentials, costs and technologies; investment patterns and international cooperation; regional development and cooperation; and national and subnational policies and institutions.

15. **Part 4** started with presentations on theme 2 of the 2013–2015 review, exploring progress made in: trends in stocks and flows of GHGs and their drivers; climate mitigation policy, value judgment, and ethical and equity concepts and considerations in the context of sustainable development; and cross-cutting investment and finance issues, with an assessment of the progress made towards achieving the long-term global goal. As in the previous three parts, the presentations were followed by a substantive discussion among experts and Parties guided by questions.

III. Summary of the discussion

A. Part 1: setting the scene for considering the contribution of Working Group II to the Fifth Assessment Report

1. Presentation by an expert

16. Part 1 of the meeting opened with a scene-setting presentation by Mr. Chris Field, Co-Chair of IPCC Working Group II (WGII), who outlined the overarching findings and new approaches of AR5 WGII that are relevant to both themes of the 2013–2015 review. He described the **concept of risk of climate-related impacts**, explaining that risk emerges from the overlap of climate-related hazards with vulnerability and exposure of human and natural systems (figure 20). The extent of climate change can therefore be controlled not only by through mitigation, but also by moderating and managing the risks of climate change (i.e. by any actions addressing vulnerability, exposure and/or hazards). Consequently, changes in both the climate system and socioeconomic processes, including adaptation and mitigation, are drivers of hazards, exposure and vulnerability.

17. Mr. Field noted that the **observed impacts of climate change are consequential and wide-ranging**, spanning across all regions and sectors (figure 21) and that, compared to the IPCC Fourth Assessment Report (AR4), the confidence levels related to the impacts of climate change are higher in the AR5. He said that we should ask ourselves whether these impacts, individually or collectively, have already crossed the threshold as defined in Article 2 of the Convention, and presented some examples of these impacts, namely: the consistent mass loss of glaciers, including that of the Himalayan glaciers; forest die backs; and wheat and maize yield decreases.[10]

18. He noted that **increasing magnitudes of warming increase severe, pervasive and irreversible impacts,** and that the decisions taken over the next two decades with regard to mitigation and adaptation will affect the risks of climate change throughout the twenty-first century. He presented two world maps prepared by IPCC Working Group I (WGI) showing projected temperature increases for the twenty-first century according to representative concentration pathway (RCP) scenarios RCP2.6 and RCP8.5, and noted that two eras can be distinguished (figure 23): a near-term era (the next few decades) where the temperature increase does not significantly depend on mitigation efforts and, therefore, adaptation provides the main options to control risks, while recognizing the essential role of mitigation investments in addressing climate change in the long term; and

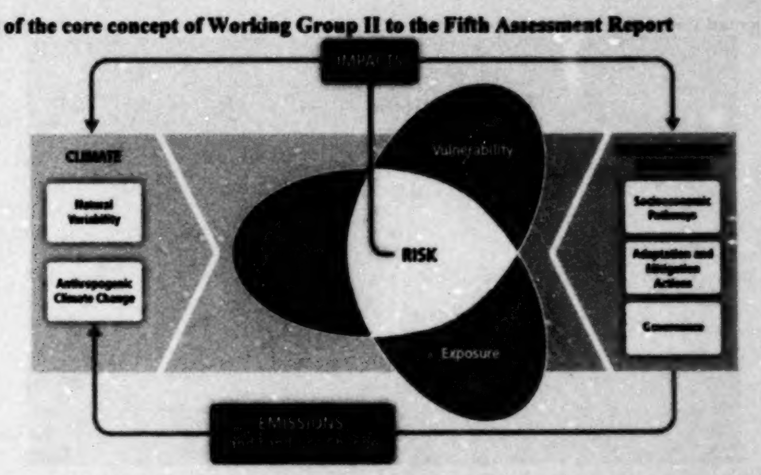
---

[10] For details of observed regional impacts, see table SPM.A1 in the summary for policymakers in AR5 WGII, available at <http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf>.

a long-term era, where there is a large difference between the projected global warming for RCP2.6 and RCP8.5. For RCP8.5, Mr. Field noted the significantly higher increase in projected temperature for land and oceans and, consequently, the associated risks compared with RCP2.6.

Figure 20

Illustration of the core concept of Working Group II to the Fifth Assessment Report



Source: Summary for policymakers in the contribution of Working Group II (WGII) to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change, figure SPM.1. The figure illustrates the constituents of 'risk' – the fundamental concept used throughout AR5 by WGII.

19. With respect to the **projected impacts** of future climate change and the importance of the rate of change, Mr. Field described a graph showing the maximum speed at which terrestrial species can move across landscapes depending on the rate of climate change, which illustrates that RCP6, the **impacts of climate change on many habitats are occurring faster than the estimated maximum speed at which most groups of organisms can move.** The impacts of climate change are therefore outrunning the speed at which ecosystems can be expected to possibly shift in order to adapt to these changes.

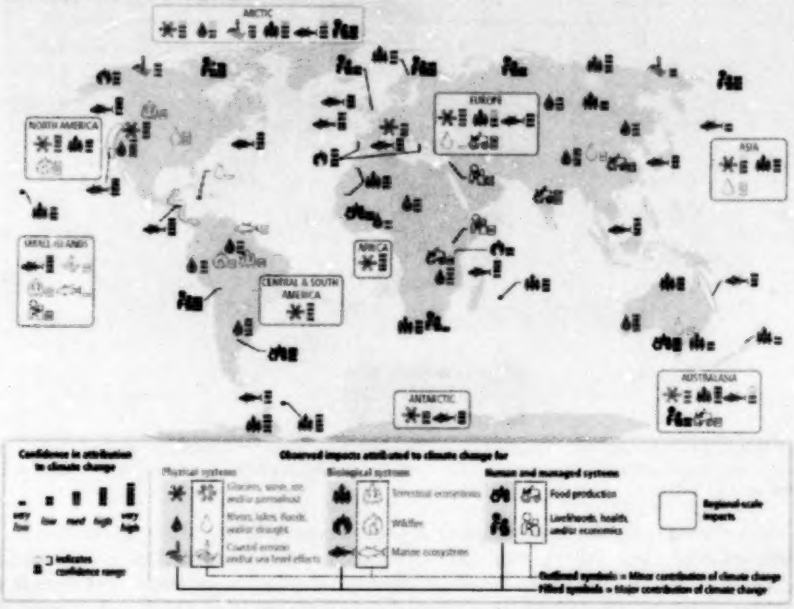
20. As regards transitioning from framing climate change in terms of temperature to **framing it in terms of risks,** he explained that one way to assess the adequacy of the long-term global goal could be to **examine the projected level of risk at 2 °C and question whether it should be decreased.** He explained that the assessment for each risk is based on an estimate of its current level, the level for the near term, and the level following a temperature rise of 2 °C and 4 °C at the end of the twenty-first century, as well as the prospects of reducing this risk based on the expert judgment of the WGII experts (figure 22). The benefits of investing in mitigation are shown by the difference in the level of risk for 2 °C and 4 °C. The grey area of each bar denoting the level of risk in figure 22 below illustrates the benefits of investing in adaptation. In the near term, the level of risk is often the same or similar for both RCP2.6 and RCP8.5.

21. Mr. Field stressed that there is a **limited prospect for risk to be reduced by adaptation action in a 4 °C warmer world**, but that there are still **significant opportunities for adaptation in a 2 °C warmer world.** However, under all of the assessed scenarios, some residual risk from adverse impacts remains. He presented examples of the assessment of key risks and prospects for adaptation in Australia and for the oceans.

22. Mr. Field explained that AR5 WGII identified **eight key climate-related risks** that span across all sectors and regions, which were identified based on expert judgment, and illustrated these risks for the main world regions. The risks can be **assessed according to the ethics, values and priorities of the various relevant stakeholders.** Furthermore, **five** integrative **reasons for concern** (RFCs) provide a framework for summarizing the key risks across sectors and regions, namely: unique and threatened systems; extreme weather events; the distribution of impacts; global aggregate impacts; and large singular events (figure 23). The first three categories are difficult to monetize. The forth category tends to be most consistent with monetization in comparison with mitigation, but does not include "all the things we care about". The last category, which also includes

irreversible impacts resulting from systems crossing tipping points, such as major ice sheet loss and a sea level rise of several metres, is also difficult to evaluate comprehensively (e.g. assessing the impacts of all major coastal cities in the world disappearing).

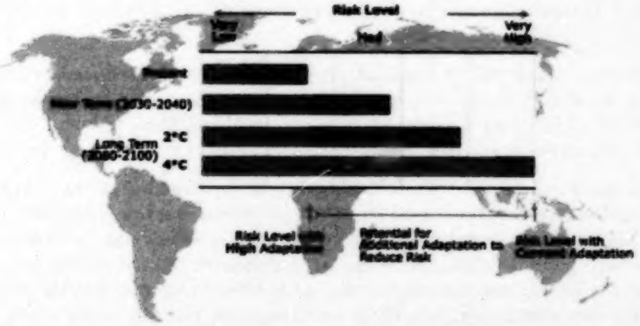
Figure 21
Widespread impacts in a changing world


ARCTIC
NORTH AMERICA
EUROPE
ASIA
SMALL ISLANDS
AFRICA
CENTRAL & SOUTH AMERICA
AUSTRALASIA
ANTARCTIC
Confidence in attribution to climate change
very low
low
med
high
very high
indicates confidence range
Observed impacts attributed to climate change for
Physical systems
Glaciers, snow, ice, and/or permafrost
Rivers, lakes, floods, and/or drought
Coastal erosion and/or sea level effects
Biological systems
Terrestrial ecosystems
Wildfire
Marine ecosystems
Human and managed systems
Food production
Livelihoods, health, and/or economics
Regional-scale impacts
Outlined symbols = Minor contribution of climate change
Filled symbols = Major contribution of climate change

Source: Summary for policymakers in the contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.2(A). The figure shows that various attributed impacts have been found in all sectors and regions, albeit with significant differences.

23. In concluding, he underlined that addressing **climate change involves managing risk**. Therefore, in order to assess the adequacy of the long-term global goal, a key element is the assessment of **when the scale** (e.g. frequency and severity) **of impacts results in a transition from 'acceptable' to 'unacceptable' at the local level.**

Figure 22
Assessing risk



Source: Slide 13 of the presentation by Mr. Chris Field (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/0_field_sedpart1.pdf>. The figure explains the risk assessment approach adopted by Working Group II to the Fifth Assessment Report.

2. General discussion

24. The ensuing discussion was guided by the following questions:

(a) What does AR5 WGII tell us about the key risks, shifts in key risk patterns and potential benefits related to climate change?

(b) How can risks be reduced through adaptation and mitigation?

(c) How reliable are the projections of risks and how can they be used for decision-making at the global level?

(d) What are the options for managing risks through adaptation and sustainable development?

25. In response to a question on the **definition of 'moderate' and 'high' adaptation,** and if 'high' adaptation implies action that is not only plausible but also possible, the expert explained that the WGII authors took into account regional development pathways when assessing 'moderate' and 'high' adaptation, and that 'high' adaptation relates to the physical limits of adaptation and is generally indicative of potential for adaptation free of serious financial constraints (see para. 57). He added that even with 'high' adaptation, residual risks remain under all scenarios, which could trigger the decision to aim for a lower temperature limit than 2 °C.

26. One Party asked how to characterize **the point**, in terms of levels of warming, **at which there is no longer adaptation but loss**. The expert said that the **transition from adaptation to loss** depends on the scale, but that, in general, when proactive adaptation by communities to pursue sustainable development is eroded, adaptation is difficult. For example, a forced relocation is considered to be adaptation if development aspirations continue to be met. If there is still a residual risk with 'high' adaptation, this is considered to be loss and damage. In terms of WGII products, if there is still a residual risk with a 2 °C temperature rise with 'high' adaptation, then that equates to damage.

27. In response to a request for more information **on the consequences of a 1.5 °C temperature rise, as opposed to a 2 °C temperature rise,** the expert clarified that AR5 WGII contains very limited assessment of the impacts of a 1.5 °C warming because of the scarce literature available to assess the impacts resulting from this limit. The RFCs presented in figure 23 summarize some of the risks related to a 1.5 °C temperature rise. He added that **near-term risk, where warming is around 1.5 °C, could serve as an operational tool to provide an approximate indication of the impacts of a 1.5 °C long-term warming.**

28. Responding to a question on how to **cooperate internationally on adaptation**, taking into account the intrinsically local nature of adaptation, the expert underlined the importance of adaptation in the global strategy to address climate change, as well as the interplay between adaptation and mitigation action. He added that adaptation relies largely on decisions made at the local, regional and national levels.

29. One participant was of the view that AR5 WGII provides very important information, including on the observed impacts and future risks of climate change, as well as opportunities for effective action to reduce such risks. A **risk framework could help to improve the decision-making process on climate change** and, in the context of urgency of action, adaptation provides the main opportunity for developing countries to address climate risks in the short term. Adaptation is therefore the highest priority for developing countries and, in this context, international cooperation on adaptation plays an important role.

B. Part 1 – theme 1: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention based on the contribution of Working Group II to the Fifth Assessment Report

1. Presentations by experts

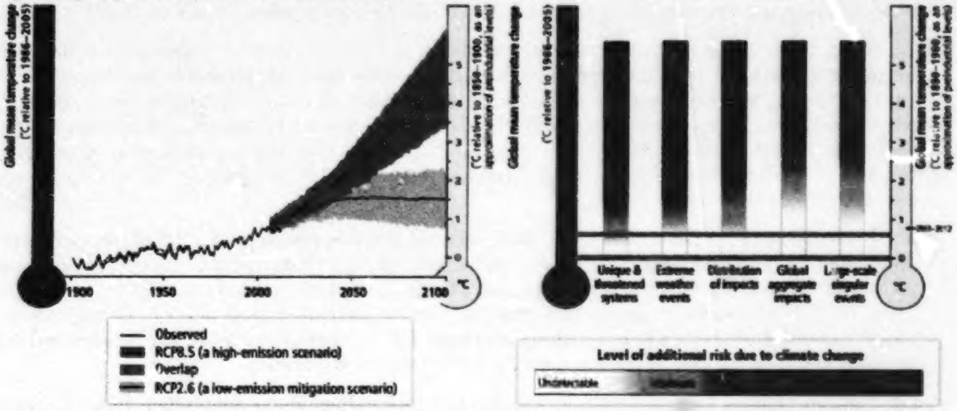
30. Mr. Joern Birkmann (IPCC) made a presentation on **human interferences with the climate system** and RFCs. He explained that the **key climate-related risks and RFCs** can be used as **vehicles to understand "dangerous anthropogenic interferences with the climate system"** in view of the long-term global goal, assuming various upper limits of global warming and a range of levels of exposure and vulnerability. The key risks are potentially severe adverse consequences for humans and socio-ecological systems resulting from the

interaction of hazards linked to climate change and the vulnerability of exposed societies and systems. The criteria for considering that a risk is 'key' is based on: the magnitude of the risk (not of the hazard); the probability that significant risks will materialize and their timing; the irreversibility and persistence of conditions that determine risks;[11] and the limited ability to reduce the magnitude and frequency or other characteristics of hazardous climate events and trends, and the vulnerability.

31. Mr. Birkmann explained that the WGII experts identified, in various chapters of AR5 WGII, over 80 regional and sectoral risks, including the hazards and key vulnerabilities that generated such risks, as being the most pressing based on the above-mentioned criteria. The risks were then condensed into **eight key risks** to avoid repetition. He provided some examples of the key risks, such as risks of death, injury or disrupted livelihoods in low-lying coastal zones (reflected in RFCs 1–5 in figure 23), risks of severe ill-health and disrupted livelihoods for large populations due to inland flooding in some regions (RFCs 2 and 3), and systemic risks due to extreme weather events leading to a breakdown of infrastructure networks and critical services (RFCs 2–4).

Figure 23

A global perspective on climate-related risks



Source: Summary for policymakers in the contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, assessment box SPM.1 figure 1. The figure shows how the additional risks associated with the five reasons for concern are affected by a low-emission scenario (RCP2.6) compared with a high-emission scenario (RCP8.5).

Abbreviation: RCP = representative concentration pathway.

32. Underlining the **multidimensional nature of vulnerability**, Mr. Birkmann noted that addressing the different dimensions of vulnerability, such as its social, economic, environmental and institutional aspects, and accounting for the dynamics of exposure and vulnerability are as important as assessing the degree of warming and its implications for weather extremes. With regard to **the dynamics of exposure**, Mr. Birkmann noted that even if the climate remains unchanged, future risk could increase. For example, in China, more people will be exposed to climate hazards as a result of population increase.

33. Mr. Birkmann explained that the eight key climate-related risks were aggregated and translated into five RFCs, which represent the level of additional risk due to climate change (figure 23). He also compared the RFCs identified in the Third, Fourth and Fifth Assessment Reports to illustrate that the past trend and scenarios for future development trends indicate that **an increase in exposure to climatic hazards will be experienced in most regions**.

34. Mr. Christian Huggel (IPCC) addressed the **observed impacts and projected key sectoral risks**, as well as the **potential and opportunities for adaptation**, with a focus on ecosystems, food production and security, economic impacts and livelihoods (aspects related to Article 2 of the Convention). He explained that WGII

---

[11] This refers to hazards as well as to societal changes.

considered chains of impacts,[12] noting that the observation and attribution of impacts to climate change and the projection of future risks becomes more difficult further down the chain, due to the influence of other convoluting factors.

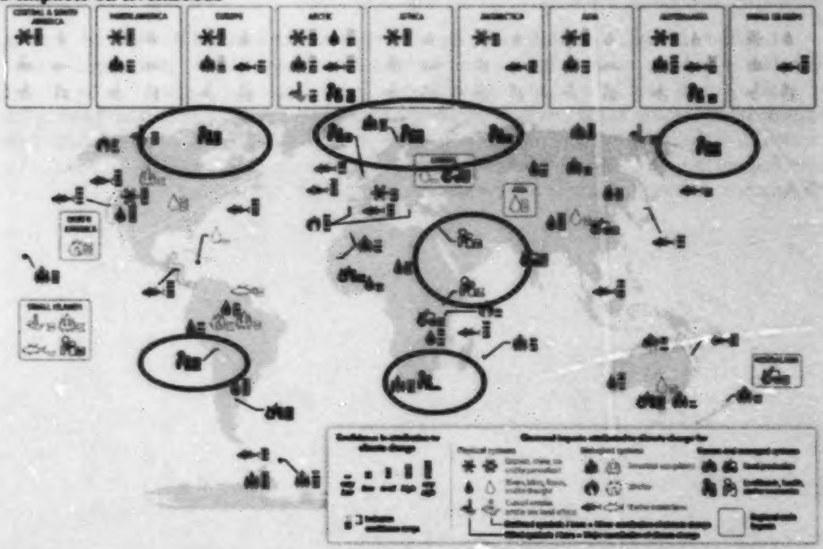
35. Mr. Huggel noted that **non-climatic factors are currently the dominant drivers of observed changes in terrestrial ecosystems**, with the exception of highly temperature-sensitive systems, such as the polar regions, high mountains and the tropics. It is worth noting that for these systems, the difference in **projected risks** between a warming of 1.5 °C and 2 °C is significant. Moreover, changes will continue to occur for many decades, even if global warming stops immediately. For example, glaciers worldwide are not in balance with the current climate (lagged response), and there can be significant differences between the level of local temperature increase and the global mean figure. Further, the delayed response in many ecosystems is key to identifying tipping points. Rising temperatures will lead to many changes, such as shifts in freshwater species, water-quality problems and an increase in the risk of forest fires.

36. On the issue of **food production and security**, Mr. Huggel noted that negative impacts of climate change on agricultural crops and marine fisheries have already been observed. Projected risks indicate an increase in negative impacts on crop yields with increasing warming, with all aspects of food security potentially being affected by climate change. **Economic losses** from extreme weather events have been increasing, mainly due to observed increases in exposure. Future losses will also be dominated by exposure (see figure 28), while vulnerability and losses due to climatic factors will also increase.

37. There is new, emerging and clearer evidence of climate change impacts on **livelihoods** (figure 24). The best evidence of these observed impacts comes from temperature-sensitive regions, such as the polar regions and high mountains. Climate change impacts are expected to slow down economic growth, jeopardize poverty reduction efforts and erode food security.

Figure 24

Observed impacts on livelihoods



Source: Slide 15 of the presentation by Mr. Christian Huggel (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_huggel_sedpart1.pdf>. The figure shows that various attributed impacts have been found in all sectors and regions, albeit with significant differences.

---

[12] For example, a temperature increase in Peru's mountainous areas will lead to glacier shrinkage, changes in water resources, and impacts on crops and cattle, as well as on livelihoods, in that area.

38. Generally speaking, the key question with regard to **projection of risk** is whether ecosystems will be able to render key services and functions under various emission pathways. **Climatic stressors will play an increasingly important role, which will then be largely determined by the emission pathway chosen.**

39. **Adaptation can effectively reduce risks if implemented in association with integrative strategies**; however, **it is restricted by a range of limits,** such as those related to space, high-emission pathways or constraints in adaptive capacity. The adaptive capacity of many ecosystems and species is insufficient for medium to high warming scenarios. In some systems, such as the cryosphere, the Arctic, high mountains or coral reefs, such limits have already been reached.

40. Ms. Penny Urquhart (IPCC) presented the observed and projected **regional impacts, risks and potential for adaptation**. Substantial adaptation deficits have been observed in some regions[13] and there is differential vulnerability to key regional risks (figure 25). Many key risks constitute particular challenges for the least developed countries and for vulnerable communities. Vulnerability is linked to multidimensional inequalities, often created by uneven development processes. She provided some examples of such differential vulnerabilities in relation to: **food insecurity and malnutrition** (high and very high risks in Africa, Asia, and Central and South Asia in relation to a global temperature increase of 4 °C); **flooding** (with most of the population affected in East, South-East and South Asia owing to an increase in exposure and vulnerability); and **hot spells and heatwaves** (in Europe, Asia and Australia).

41. With regard to **regional adaptation trends**, Ms. Urquhart described the development of adaptation actions and policies in all regions, noting growing experience in Asia, Africa, Central and South America, small islands and the Arctic, through a combination of traditional and scientific knowledge and community-based adaptation. Common adaptation trends for these regions include ecosystem-based adaptation, growth of resilient crop varieties, expansion of agro-ecological approaches, and climate forecast and early warning systems. However, most adaptation in developing regions remains autonomous, reactive and unsupported, and not at scale. In Europe and North America there is greater involvement of adaptation governance systems, as well as more capacity, experience and resources at the municipal level.

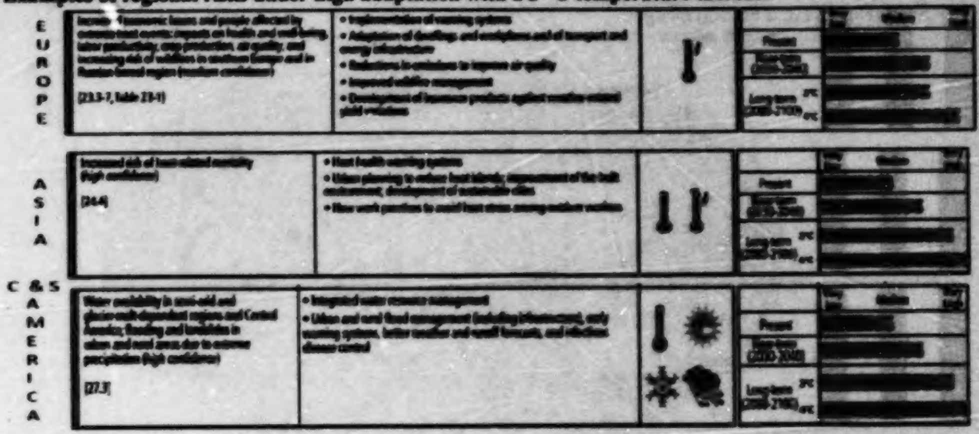
42. Ms. Urquhart noted that **while some regional risks can be reduced through adaptation, others may be intractable**, such as threats to freshwater, terrestrial and marine ecosystems in the polar regions, threats to low-lying areas of small islands, and reduced biodiversity in and coastal protection from coral reefs in Australasia, small islands around the world and the east coast of Africa. While risks related to flooding can be reduced by adaptation from the category medium to very low in Europe in the case of a 2 °C temperature rise, flooding risks remain medium to high even with adaptation for the same amount of warming in Asia and in Central, South and North America, and would become more widespread with a 4 °C temperature rise.

---

[13] For example, adaptation deficits have been observed for risks relating to food security in some parts of Africa, declining food production and quality in Central and South America, and food production in some regions of Australia.

Figure 25

Examples of regional risks under high adaptation with a 2 °C temperature increase


EUROPE
[23.3-7, table 23-1]
ASIA
[24.4]
C & S AMERICA
[27.3]
Present
Long term 2°C 4°C

Source: Slide 12 of the presentation by Ms. Penny Urquhart (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_penny-sedpart1.pdf>. The figure shows how the risk assessment approach of figure 3 was applied in a regional context.

43. Significant **adaptation challenges are distributed unevenly across and within regions**, and some risks may be reduced in some regions but not others. For example, all nine assessed risks for Africa remain high or very high under current levels of adaptation under a 2 °C warming scenario. Adaptation policies and measures will be more effective if they address the underlying causes of poverty and inequality. However, many residual impacts will remain under a 2 °C warming scenario, even with 'high' adaptation, and these impacts will significantly increase under a 4 °C warming scenario for all regions.

44. Mr. Hans-Otto Pörtner (IPCC) made a presentation on **climate-related impacts on the world's oceans.** He outlined climate-related ocean issues, noting the key role of oceans in the climate cycle and the influence of human activities on ocean conditions. Temperature increase is currently the predominant driver of ongoing global changes, leading to shifts in biogeographical distributions of marine organisms. These changes are projected to continue in the future, leading to shifting stocks across fishing zones as organisms migrate to stay within their thermal tolerance range. For commercial species, an impoverishment at lower latitudes with a shift of stocks to higher latitudes is projected by the mid twenty-first century with a 2 °C warming (figure 26). These changes will result in risks to humans and infrastructure. Human adaptation options include the large-scale relocation of industrial fishing activities, but such options are limited for artisanal local fisheries and only exist in the near term, even for a 2 °C temperature increase.

Figure 26

Change in maximum catch potential (2051–2060 compared with 2001–2010, *Special Report on Emissions* Scenarios, A1B, 2 °C warming)

<50%
-21 - 50%
-6 - 20%
-1 - 5%
No data
0 - 4%
5 - 19%
20 - 49%
50 - 100%
>100%

Source: Summary for policymakers in the contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.6(A). The figure illustrates the significant projected change in a marine ecosystem service–based, fishery-related parameter for a global mean warming of only 2 °C.

45. As regards the degree of **ocean acidification**, projections depend on the emissions scenario and are associated with an uneven global pH distribution in the oceans and higher acidification in the polar regions. The human adaptation option of shifting to using more resilient species or protecting habitats with low natural carbon dioxide (CO_2) levels only exists in the near term and not in the long term, even for a 2 °C temperature increase, owing to the sensitivity of species, especially with a high level of acidity of the oceans.

46. Mr. Pörtner noted that **oxygen levels in oceans are decreasing** and explained that the tolerance of organisms to low oxygen levels depends on their complexity, and larger body size organisms generally tend to be more vulnerable. Areas devoid of animal life are expanding. Underlining the **interaction of warming, acidification and hypoxia**, he stated that in animals, the strongest impacts are expected where these factors combine, indicating that assessments based on individual drivers are conservative.

47. On the issue of **sea level rise, beyond 2100** a rise of up to six or seven metres in 2500 is projected,[14] depending on the emissions scenario, with a high level of uncertainty. An examination of palaeo-analogues reveals that a sea level rise of this magnitude occurred in the Pliocene age, when atmospheric CO_2 concentrations were 400 ppm, and in the last interglacial period, when temperatures were about 2 °C above pre-industrial levels.

48. Regarding the impacts of climate change on **vulnerable ecosystems**, Mr. Pörtner focused on warm-water coral reefs and the Arctic sea ice ecosystem. With respect to warm-water coral reefs, the impacts include the bleaching and die off of corals, and an increase in predators. **To protect at least 50 per cent of the coral reefs, the global mean temperature change would have to be limited to 1.1–1.4 °C** (without taking into account the effects of ocean acidification), especially given the lack of evidence to demonstrate that corals can evolve significantly on decadal timescales and under continually escalating thermal stress. As regards the Arctic sea ice ecosystem, summer sea ice is projected to be marginalized and to disappear by the mid twenty-first century under the highest warming scenarios.

49. In conclusion, Mr. Pörtner underlined that, with respect to ocean-related risks, **adaptation "buys time", but is very limited for some systems, such as the polar regions and coral reef systems.**

---

[14] See the contribution of WG I to the AR5, table 13.8, available at <http://www.ipcc.ch/report/ar5/wg1>.

2. General discussion

50. The ensuing discussion was guided by the following questions:

(a) What impacts has the world observed, and what are the projected key risks and opportunities for the natural, human and managed systems at various levels of temperature increase?

(b) What is the regional variability of observed impacts and projected key risks and opportunities under various warming scenarios?

(c) Is there a difference in impacts, on both oceans and land, of a global warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(d) What level of warming could be interpreted as dangerous and for what reasons, considering the associated scientific uncertainties?

(e) What uncertainties remain? What is their role in a risk management context? Are they calling for a global policy response?

(f) How do the above-mentioned findings relate to the adequacy of the long-term global goal in the context of policymaking in the UNFCCC process?

51. **Regarding the relationship between mitigation and adaptation**, a Party asked for clarification as to what extent these two actions depend on each other. An expert pointed to the existence of co-benefits and synergies between adaptation and mitigation actions. He said that the most attractive options for actions are those that have a mitigation and adaptation component and contribute to sustainable development. Another Party underlined the benefits of **setting mitigation and adaptation goals** and fully considering the risks of different pathways, which is important in the context of the 2013–2015 review. Responding to a question on the urgency of taking action on climate change and the long-term perspective, an expert noted the profound benefits of early action, adding that mitigating to RCP2.6 depends heavily on rapid action, in a manner that society has never before experienced.

52. **With regard to the assessment of the 1.5 °C limit**, a Party asked if more literature would be made available in the near future. In response, an expert referred to recent literature on the possible irreversible loss of the West Antarctic ice sheet, noting that if these still tentative findings are to be further confirmed and strengthened, the level of risks for RFC 5, including such a large-scale singular event with its inevitable and significant sea level rise, would have to be reassessed and increased. Another Party added that there is now a case for reviewing the level of risk associated with the RFCs for sea level rise since there would already be a high risk under the 2 °C warming scenario based on this new information.

53. Regarding the **difference in impacts**, on both oceans and land, **of global warming of 1.5 °C and 2 °C** relative to pre-industrial levels, an expert reiterated that literature available to assess the 1.5 °C limit (see para. 27 above) is scarce. Another expert stressed that this may also be due to the fact that many scientists are unaware of the fact that a 1.5 °C warming is being discussed by policymakers. He added that the understanding of some physical systems, such as glaciers and permafrost, hinder the response to this question. For agricultural and human systems, the difference between a 1.5 °C and a 2 °C temperature rise is becoming increasingly difficult to assess. Yet another expert underlined the need to address this question in terms of the differences between vulnerability and exposure at these temperature level rises. To this end, for some regions the consequences of a 2 °C warming will be significantly different from those created by a 1.5 °C warming, in particular for low-lying coastal regions. An expert noted the need to consider large-scale changes and pointed to the benefits of the 1.5 °C warming scenario for vulnerable ecosystems such as coral reefs and the polar regions.

54. An expert stressed that current levels of warming are already causing impacts beyond the adaptive capacity of many people, and that there would be significant residual impacts even with a 1.5 °C warming (e.g. for sub-Saharan farmers), emphasizing that it would be preferable to move the limit downwards to 1.5 °C. Another expert noted that some technologies and policies required to effectively deal with a 1.5 °C temperature rise may negatively impact poverty reduction efforts. Yet another expert recalled that impacts are already occurring and that risk will increase with the degree of temperature rise. Therefore, even if studies that identify different risks at 1.5 °C and 2 °C are scarce, there is a high likelihood of meaningful differences between these temperature limits as regards the level of risk of extreme events or tipping points. He then raised the question whether the long-term global goal is a 'guardrail' or societally determined agreement on an acceptable limit. He

emphasized that the 'guardrail' concept is inadequate, as impacts are already occurring and having significant effects. Therefore, the long-term global goal should be the limit above which the impacts will become too widespread and unacceptable across the RFCs; setting this limit depends on the values and interests of Parties.

55. **On the issue of regional differences**, a Party underlined the importance of a 1.5 °C temperature rise limit for some regions, as well as the disproportionate distribution of impacts and differences in the amount of literature for some regions. He asked about the risks of conflicts at the local and regional levels, especially when water resources are become scarcer. An expert said that it is often the case that the least amount of research is conducted and literature is available for the most vulnerable regions, stressing the need for more research. He added that this need is most acute in relation to projecting impacts and characterizing risk, particularly for high degrees of warming. He also noted a growing volume of literature on human security and indicated that the issue of conflicts would be discussed in part 2 of the meeting. Another expert added that the IPCC experts made great efforts to include traditional and indigenous knowledge in their assessment, and that there have been significant improvements in the assessment of risks related to high mountain ecosystems, in particular the Andes and the Himalayas.

56. In response to a question relating to the **regional and global food security risk at different levels of warming**, taking into account the large differences in risks between the local and regional levels even under the 1.5 °C and 2 °C warming scenarios, an expert stated that for any level of warming, regional differences are going to be large, thereby underlining the importance of using a risk-based framework. Another expert pointed to the chapter of AR5 WGII on Africa, where the levels of risk for some countries such as South Africa and Zimbabwe are higher than at the global level with, for example, a reduction in maize yields of up to 30 per cent by 2050.

57. One Party asked about the **disconnect between the prospects for 'high' adaptation at the global level and realities at the regional level**, in particular for regions where some impacts are projected to be irreversible, such as the polar regions and small island developing States. An expert clarified that the reality on the ground was built into the assessment, since the experts based their assessment of 'high' adaptation on the most probable development pathways for each region using pertinent regional information, as currently available. Another Party mentioned the difference between the levels of risk at the global and local levels for the same temperature scenario, and the fact that the local temperature increase can be higher than the global mean level. Another expert replied by underlining the importance of the regional assessments, adding that regional risk could not be deducted from global scenarios.

58. Responding to a question on what can constitute a **limit to 'high' adaptation**, an expert noted that constraints to 'high' adaptation are sensitive to the particular issue and reflect the fact that adaptation is difficult to assess, particularly for long-term time frames (2040 and 2100). Another expert added that, in addition to biophysical and economic limits, which persist as long as adaptation is not seen as a cost-effective investment, limits to adaptation can be perceptional or cultural.

59. In response to a question related to timescales associated with **planetary equilibrium**, an expert noted the discrepancy between the fact that ocean warming reduces the impact of climate change, and that this may delay both attainment of the equilibrium and our response to climate change, thereby increasing the difficulty of addressing this challenge. According to the warming scenarios, the equilibrium in terms of temperature and sea level would only be reached after several centuries.

60. As regards the role of **non-climate stressors**, in particular those related to sea level rise, a Party asked if it were possible to look beyond exposure and vulnerability to identify the types of development or urbanization decisions that will drive down the climate signal. An expert pointed to lessons learned from past extreme events that could guide urbanization and development decisions, including the opportunities and limits associated with steering the urbanization process. He stressed that a better strategy is to think in terms of urbanization scenarios and define a larger protected area rather than simply defining a threshold for protected and unprotected areas. The AR5 shows that rural–urban migration is a "moving target" that should be considered within the context of land-use planning and the development of risk reduction strategies. Another expert noted that the risk framework allows for a better understanding of the role of non-climatic stressors.

61. In response to a follow-up question regarding **losses due to the placement of economic assets or human settlements and their attribution to climate change**, an expert pointed to the subtle but important difference in the definition of attribution between WGI and WGII given the nature of the systems studied. The chapter on

attribution in AR5 WGII emphasizes the need to recognize that the baselines, in particular for human systems, are constantly changing. Therefore, the literature that would enable a distinction to be drawn between anthropogenic and natural climate change in the sphere of WGII does not currently exist and future work is required, including research on methodologies. Highlighting the increasing cascading effects of impacts, another expert stated that, although there can be a clear climate signal, attribution in the strict sense is often unclear. For example, in the case of Hurricane Sandy, the major impacts came from secondary effects on infrastructure and their attribution to climate change is unclear. He noted the political interest in subdividing these components and highlighted the need to recognize the complexities involved in attribution and to consider this matter within the context of a risk management framework.

62. With respect to **progress made in determining metrics for adaptation**, an expert explained that the WGII experts moved away from using a single metric to assess adaptation needs and options, based on the recognition that the best adaptation options address multiple dimensions of vulnerability and contribute to other mitigation and sustainable development goals. It is therefore very difficult to apply an additionality criterion to evaluate the effects of adaptation investments. Adaptation options that affect the trajectory of societal development are very difficult to evaluate with a simple metric, precisely because of the simultaneous difference occurring across a multitude of aspects.

63. Responding to a follow-up question on the global and regional **consequences associated with a 50 per cent loss of coral reefs**, an expert noted that the location of the reefs would determine the magnitude of the loss, which would depend not only on many local factors influencing the fate of the coral reefs, but also on the value of the reefs in relation to the various ecosystem services they render. The total value of coral reefs, probably the most vulnerable and valuable ecosystem, is estimated at more than USD 600 billion; a 50 per cent loss would therefore be significant. He stressed that the loss of coral reefs has already begun and that the prospects for adaptation are very low. The adaptive capacity of coral reefs may only play a limited role at the present rate of temperature change and ocean acidification (limited evidence). Another expert added that there is some evidence indicating that coral reefs in the West Indian Ocean may be more resilient than those in the East Indian Ocean.

64. Responding to questions raised by two Parties **on the qualification of risk**, including on how some risks have been deemed as high and how local risks have been used to determine regional risks, an expert explained that AR5 WGII includes hundreds of diagrams depicting risks and that the challenge is to understand the meaning of these diagrams in relation to the long-term global goal and Article 2 of the Convention. He added that WGII used expert judgment on the level of risk and the possibility for adaptation based on a series of explicit criteria, in accordance with the IPCC's mandate. Another expert explained that the experts involved in compiling chapter 19 of the WGII report used information on risks from other chapters of the report to identify key risks, which were then condensed into eight key risks (see para. 31 above). Local high risks are included in the tables of the underlying report as the experts assessed not only global but also local studies and local risks (e.g. in urban areas), and identified generalizable aspects.

65. One Party asked if there are areas of change with respect to different levels of stabilization where a **rapid change in risk levels** may take place from a regional, sectoral, systemic or integrated point of view, in order to help policymakers focus on such areas. An expert explained that the WGII report not only identifies the risk levels, but also the changes in risk levels. For example, in chapter 19 of the report, hot spots have been considered (e.g. areas where risk is very high or where risk levels could change significantly). Low-lying coastal areas in Asia pose a particular challenge, in part because of their expected increase in exposure. Sub-Saharan Africa also poses a challenge, as a result of increased vulnerability and overlapping climate hazards. Focusing on these changes should make mitigation and adaptation policies more effective (e.g. policies aimed at reducing exposure or vulnerability). Another expert underlined the non-linear aspect of organisms' responses to climate stressors, noting that determining thresholds may not be a useful exercise and that it would be preferable to determine instead the degree of change that is tolerable. Yet another expert noted that it is important to study the ways in which risks interact. In terms of RFCs, these interactions are better understood for global aggregated impacts, but other RFCs should be further examined. In response to a follow-up question from Mr. Fischlin, co-facilitator, regarding the effect of mutual drivers exacerbating risks and impacts, an expert explained that climate change impacts are complicating existing risks and that societal stress is generated by multiple interacting impacts. A deeper understanding of these interactions will allow the IPCC to better estimate climate risks.

66. A Party questioned the **comparability of studies and risks** and asked **how different risks could be weighted** (e.g. comparing risks to coral reefs with risks to subsistence farming in Africa). An expert noted the

change in terminology from "vulnerability" in AR4 to "risk" in AR5. While recognizing that "vulnerability" is a more ecological concept whereas "risk" is derived from a disaster risk management perspective, he stated that the risk concept is robust and enables better comparability. However, risks for farmers could be caused by, for example, extreme events and droughts, while for coral reefs the risks could be caused by ocean acidification. Another expert commented on the challenges involved in comparing studies that use different methodologies, noting in particular the inconsistent use of estimates of adaptation costs, not all of which factor in the existing adaptation deficits, and indicated that AR5 WGII highlights these constraints.

C. Part 2 – theme 2: overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention based on the contribution of Working Group II to the Fifth Assessment Report

1. Presentations by experts

67. Mr. Lennart Olsson (IPCC) made a presentation on the **links between socioeconomic pathways and climate change risks**, with a focus on poverty and livelihoods. Stressing the multidimensional aspects of poverty, he said that income poverty is complemented by other dimensions, such as health, education, access to basic services and standard of living, noting that there are more people living in multidimensional poverty than there are people qualified as "poor" according to the traditional economic approach to poverty. He explained that climate change may damage six types of assets that are crucial to maintaining livelihoods, namely: natural (e.g. vegetation, soil, water, climate); human (e.g. skills); physical (e.g. land); social (e.g. mobilization capacity); financial (e.g. savings); and cultural (e.g. identity, sense of place, knowledge).

68. Mr. Olsson highlighted **three key risks** from climate change for people living in poverty and their livelihoods, namely the risks of: **deteriorating food security**; **deteriorating access to water**; and **increasing heatwaves** (figure 27). As regards the risk of deteriorating food security, he underlined that the current risk is low, but that there is little adaptation potential due to low government support or the exclusion of small-scale farmers. In the near term (2030–2040), the adaptation potential is significant but requires adaptation capacity to be strengthened. With regard to the risk of deteriorating water access, he indicated that some areas are already subject to high risks but that adaptation opportunities exist. Rainwater harvesting technologies are inexpensive but not sufficiently deployed due to social and economic constraints. Regarding the risk of increasing heatwaves, which is currently low, adaptation potential exists. However, this potential is very limited for people living in poverty in both the near term and the long term. He added that the potential for adaptation to heatwaves for those carrying out physical outdoor work is very limited, and presented a figure illustrating the integration of key climate hazards, farm work and possible diseases to determine periods of hardship, coping and recovery for each month of the year.[15]

69. As regards **extreme events**, risks from hurricanes and floods are projected to increase, and in some areas migration may be an adaptation option (figure 28). There is no large difference in the number of people exposed to **flood risk** in the various RCP scenarios until 2050. However, if GHG emissions continue to increase in line with RCP8.5 or RCP6.0, the risks will become very high in the second half of the twenty-first century, and some will be beyond the limits of adaptation for the poor. Under the lower GHG emission scenarios, the flood risk remains manageable in the second half of the twenty-first century.

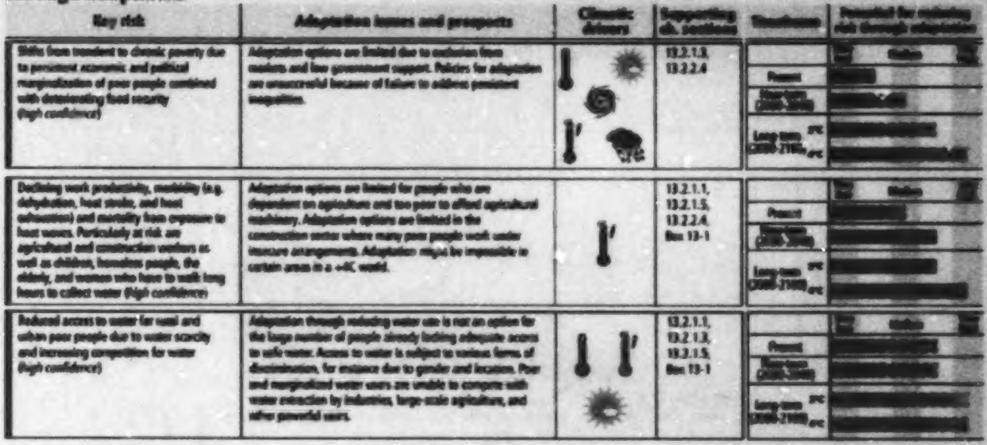
70. Mr. Olsson concluded that **various forms of inequality will make people more vulnerable to climate change; high risks already exist for the poor, both at present and in the short term; warming above 2 °C will imply very high risks after 2050** and in some cases may reach adaptation limits (e.g. coastal flooding and heatwaves); and **current mitigation policies may negatively impact poor people**, thereby stressing the need for policies that take into account the circumstances of those living in poverty.

---

[15] See AR5 WGII, figure 13.4.

Figure 27 4

Key risks from climate change for poor people and their livelihoods and the potential for risk reduction through adaptation



Key risk	Adaptation issues and prospects	Climatic drivers	Supporting ch. sections	Timeframe	Potential for reducing risk through adaptation
Shifts from transient to chronic poverty due to persistent economic and political marginalization of poor people combined with deteriorating food security (high confidence)	Adaptation options are limited due to exclusion from markets and low government support. Policies for adaptation are unsuccessful because of failure to address persistent inequalities.		13.2.1.3, 13.2.2.4	Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	
Declining work productivity, morbidity (e.g. dehydration, heat stroke, and heat exhaustion) and mortality from exposure to heat waves. Particularly at risk are agricultural and construction workers as well as children, homeless people, the elderly, and women who have to walk long hours to collect water (high confidence)	Adaptation options are limited for people who are dependent on agriculture and too poor to afford agricultural machinery. Adaptation options are limited in the construction sector where many poor people work under insecure arrangements. Adaptation might be impossible in certain areas in a +4°C world.		13.2.1.1, 13.2.1.5, 13.2.2.4, Box 13-1	Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	
Reduced access to water for rural and urban poor people due to water scarcity and increasing competition for water (high confidence)	Adaptation through reducing water use is not an option for the large number of people already lacking adequate access to safe water. Access to water is subject to various forms of discrimination, for instance due to gender and location. Poor and marginalized water users are unable to compete with water extraction by industries, large-scale agriculture, and other powerful users.		13.2.1.1, 13.2.1.3, 13.2.1.5, Box 13-1	Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	

Source: The contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, table 13.2. The figure illustrates the key risks from climate change for poor people.

71. Ms. Purnamita Dasgupta made a presentation on **rural areas and human settlements**. She highlighted that almost 50 per cent of the world's population and 70 per cent of the developing world's poor live in rural areas. Poverty rates in rural areas are high but are falling sharply, except in sub-Saharan Africa. Multiple non-climate stressors of vulnerability affect rural areas. Owing to their low adaptive capacity, geographical location, and high dependence on natural resource based livelihoods and agriculture, climate-related impacts on rural communities in developing countries are projected to be more significant than in developed countries. Evidence of such impacts already exists, including with regard to water access, food security and agricultural production. Rural areas in developing countries are also subject to secondary impacts and trade-offs between mitigation and adaptation policy affecting rural livelihoods, such as that on biofuels and on reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+) (see the discussion on biofuels in paras. 83, 108 and 115 below).

72. Ms. Dasgupta drew a distinction between **two types of adaptation** interventions: one that relates to **access** to credit, land, water, technology, markets, knowledge and information; and the other that relates to **perceptions** regarding the need for change in terms of relative neglect, lack of voice or lack of information.

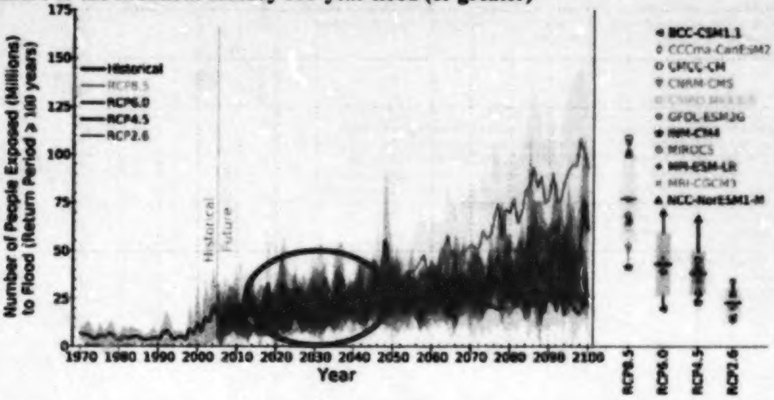
73. She then discussed the different scales at which the **interaction of hazards, vulnerabilities and adaptation takes place in rural and urban areas**, focusing on the risk of drought and water shortage in rural areas, and of inland and coastal flooding in urban areas. While noting that climate change impacts rural and urban areas in different ways, she drew attention to **rural–urban interactions**, in particular how climate change stressors can exacerbate rural–urban conflicts related to the management of natural resources. Sectoral interactions also exist; for example, irrigation increases climate resilience for food and fibre production, but reduces water availability for other uses, such as energy production.

74. Ms. Dasgupta underlined that the **differential impacts of climate change** across people, countries and time **lead to situations of trade-offs and synergies**, creating challenges for a comparison of values. In this context, economic valuation of impacts and adaptation costs are key inputs for decision-making. However, costing challenges exist when evaluating non-market goods and services that cannot be monetized, especially where communities and economies are directly dependent on ecosystem services. It is possible to follow a multi-metric approach that uses a mix of quantifiable and non-quantifiable costs, and monetary and non-monetary metrics (e.g. declining calorie consumption per capita). However, considerable challenges remain in relation to distributional impacts and uncertainty.

75. Ms. Dasgupta concluded that a variety of interventions are effective for **adaptation in human settlements**, including incentives, regulation and instruments, and underlined the role of the public sector in removing institutional barriers, providing basic public health and amenities and protecting biodiversity.

Figure 28

Global exposure to the twentieth century 100-year flood (or greater)



Source: The contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 3.6. The figure shows the number of people exposed to floods under historical and future scenarios of climate change.

Note: The abbreviations on the right-hand side of the figure identify the models used (see figure 3.6 for details).

Abbreviations: RCP = representative concentration pathway;

76. Ms. Balgis Osman-Elasha made a presentation on **adaptation options, needs, opportunities and associated costs**. She noted that the framing of adaptation has moved from a focus on biophysical vulnerability to the wider social and economic drivers of vulnerability and people's ability to respond. The **definition of adaptation** in AR5 is slightly different from that used in AR4, as it distinguishes more explicitly between human and natural systems. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities, while in natural systems, human intervention may at best facilitate adjustment to expected climate change and its effects. The theory and the evidence indicate that, in general, adaptation cannot overcome all climate change effects.

77. Regarding **adaptation needs**, Ms. Osman-Elasha explained that they arise when the anticipated risks or experienced impacts of climate change require action to ensure the safety of populations and the security of assets, including ecosystems and their services. The concept of 'needs' has evolved from national adaptation programmes of action (NAPAs), where needs were identified as priority adaptation activities, and the focus has shifted from biophysical vulnerability to a focus on the wider social and economic drivers of vulnerability and people's ability to respond. The AR5 introduces an iterative risk management framework for adaptation, which includes a long-term practice of assessing and reassessing the effectiveness of past decisions within a continuous learning process (figure 29).

78. She grouped **adaptation options**, which refer to the strategies and measures available to address needs, into three categories: structure/physical; social; and institutional. The AR5 emphasizes the role of institutional options for identifying, developing and pursuing climate-resilient pathways, as well as technological innovation and integration of adaptation development planning. Many of the technological and engineering options are still the most commonly used strategies, but there is growing recognition of the value of ecosystem-based adaptation. The options for addressing needs in ocean systems are still poorly developed. AR5 WGII outlines the opportunities, constraints and limits to adaptation in different sectors and regions.[16]

79. On the issue of **costing adaptation**, she underlined that global adaptation cost estimates are greater than current adaptation funding and investments, particularly in developing countries, thereby suggesting a funding

---

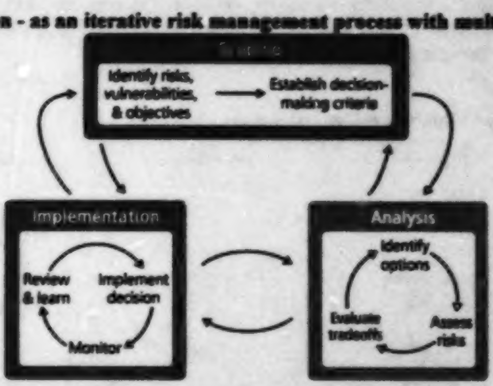
[16] See the AR5 WGII, table 16.3.

gap and a growing adaptation deficit. The World Bank estimates that the global need for adaptation funds is in the range of USD 70–100 billion per annum, with actual expenditures estimated at USD 244 million in 2011 and at USD 395 million in 2012. She noted that a variety of approaches were used to calculate the estimates, generating considerable uncertainty regarding the full range.

80. In concluding, Ms. Osman-Elasha stressed that: adaptation assessments have demonstrably led to a general awareness among decision makers and stakeholders of climate risks and adaptation needs and options, but that this has often not translated into adaptation action; adaptation generally needs to be seen within the framework of the overall development pathway of the country, particularly for developing countries; opportunities exist to enable adaptation planning and implementation for actors across all sectors and geographic regions; and successful adaptation requires not only identifying adaptation options and assessing their costs and benefits, but also exploiting available mechanisms to expand the adaptive capacity of human and natural systems.

Figure 29

Climate-change adaptation - as an iterative risk management process with multiple feedbacks



Source: Summary for policymakers in the contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.3. The figure shows adaptation understood as part of an iterative risk management process.

81. Ms. Asuncion Lera St. Clair made a presentation on **climate-resilient pathways** and the relationship between adaptation, mitigation and sustainable development. Regarding the informational basis used by AR5 WGII, she pointed to a large increase in the literature on climate change and especially on adaptation, enabling a clearer view of the risks posed by climate change. She also noted an enhanced knowledge of the interactions among adaptation, mitigation and sustainable development. Such a holistic, integrated perspective grounded in an extensive, multidimensional set of research results provides the informational basis for analysing risks and options for solutions; identifying links among adaptation, mitigation and sustainable development; and making decisions and choices.

82. Underlining that adaptation as an isolated set of actions may have limited consequences because of the multiple interactions between human and natural systems, Ms. Lera St. Clair stressed that: **adaptation and mitigation are interdependent**; they can both reduce climate risks but do so according to different timescales; adaptation addresses current and committed climate change; mitigation reduces future climate risks; and **adaptation and mitigation choices in the near term will affect the risks of climate change throughout the twenty-first century**.

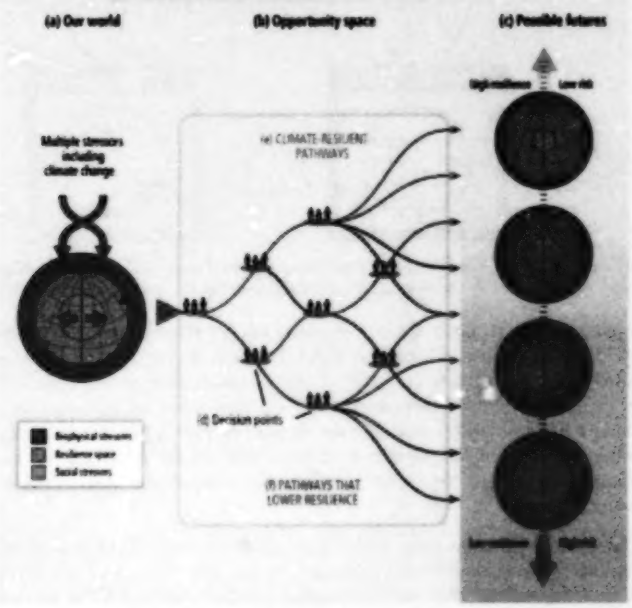
83. On the issue of **risks and trade-offs between adaptation and mitigation**, she stated that the integration of mitigation and adaptation responses can generate mutual benefits and co-benefits with sustainable development, but may also lead to negative consequences if choices are not carefully analysed, pointing to the example of land use for biofuels or food, or REDD+ programmes that lead to livelihood losses (see para. 115 below). She added that while climate change poses a moderate threat to current sustainable development in general, there are cases of residual damage and limits to adaptation. **In the future, climate change will pose a severe threat to sustainable development**.

84. She described **climate-resilient pathways** as development trajectories that combine mitigation and adaptation to realize the goal of sustainable development and help to avoid "dangerous interference with the climate system". Climate-resilient pathways include actions to ensure that effective risk management and adaptation can be implemented and sustained while avoiding negative consequences from trade-offs. While recognizing that effective adaptation strategies that are linked with development and have mitigation co-benefits can help to reduce vulnerability, she underscored the need for more research on the benefits, synergies, trade-offs and limitations of major mitigation and adaptation options, along with their implications for sustainable and equitable development.

85. Ms. Lera St. Clair highlighted that **the prospects for climate-resilient pathways are fundamentally related to progress on climate change mitigation**, while stressing that both mitigation and adaptation are essential for climate risk management at all levels. Delayed action reduces the number of options for the future because high emission pathways will reduce future options for climate-resilient pathways as adaptation limits are reached. To promote sustainable development within the context of climate change, climate-resilient pathways may involve significant transformations in political, economic and sociotechnical systems. These transformations, which have ethical and equity dimensions, may be reactive, forced or induced, as well as deliberatively created through social and political processes.

Figure 30

Opportunity space and climate-resilient pathways



Source: Summary for policymakers in the contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.9. The figure demonstrates that climate-resilient pathways offer some flexibility, yet depend on past decisions, which can significantly reduce or enhance future potentials.

86. In concluding, she noted that the expanded scientific focus of AR5 WGII, combined with increased practice and experience with adaptation, as well as with synergies with mitigation and development, creates opportunities for evaluating policy options and their risks in the search for climate-resilient development pathways. The opportunities show that there is still time in which to avoid the catastrophic effect of climate change, and that various decision points and pathways that lead to a more resilient world exist (figure 30).

2. General discussion

87. The discussion was guided by the following guiding questions:

(a) What does AR5 WGII tell us about the overall progress on adaptation made thus far and the projected progress in view of the long-term global goal?

(b) Are the existing adaptation activities adequate and effective, particularly in terms of the support provided to developing countries?

(c) What are the adaptation costs associated with various mitigation pathways as defined by their degree of global mean warming?

(d) What are the adaptation options, needs, opportunities and costs associated with the projected risks?

(e) What are the differences in terms of adaptation options, needs, opportunities and costs between various groups of people as determined by their livelihoods, poverty and development level?

(f) What types of adaptation are the most promising to cope with the various climate change risks?

(g) What is the relationship between the key climate risks and various levels of global temperature rise in the long term, including the possible impacts beyond 2100? How can this be factored into policymaking under the Convention?

88. As regards the **adaptation funding gap** in developing countries, a Party mentioned that the costs of adaptation could be higher in these countries due to, inter alia, the economic situation, the large population and socioeconomic aspects. The experts answered that many of the studies on adaptation costs, including a study by the World Bank,[17] focus on developing countries, and that the findings on adaptation costs were not included in the AR5 WGII summary for policymakers because of the wide range of figures.

89. Responding to a question on whether the estimates of **adaptation costs** were calculated in the light of developing countries' needs or the funding available, and in response to a comment on the discrepancy between the actual costs of adaptation and the costs estimated by some models, an expert answered that adaptation costs are typically estimated based on needs rather than on available or spent funds. Another expert added that the aggregated costs of adaptation, estimated using a top-down approach and not by sector, are uncertain and the estimates differ, not least because of the discrepancy between needs and actual expenditures (with expenditures being in the order of one per cent of the needs), mentioning the specific estimates calculated in a World Bank study (see para. 79 above). Another expert explained that the costs of adaptation and of climate change need to be clearly distinguished. The former is calculated using evidence from foreign domestic aid, such as NAPAs and non-governmental studies. The latter is related to loss and damage, which is difficult to capture with economic models, in particular because models use damage functions that are incapable of capturing the reality, poorly represent extreme events, and use only a percentage of gross domestic product (GDP), meaning that model-based estimates are most likely to provide only a lower indication of actual adaptation costs. The experts further commented that some adaptation costs, such as loss of place or culture are difficult to monetize; that costs differ significantly between studies owing to the assumptions used and as a result of the limitations arising from uncertain or incomplete damage functions; that externality costs or ancillary costs are not included in the cost estimate; and that there is a need for additional information, including on the costs of adaptation by sector, and actual data rather than estimated data.

90. One Party commented that **costs will depend on the definition of "adaptation"**, noting the difficulty in distinguishing between adaptation and general development flows, and asked if the differences between the cost estimates of various studies may be due to the different definitions used for "adaptation". An expert responded that the World Bank launched a study to track adaptation versus development financing,[18] and that if the methodology proposed in the study is used, more reliable adaptation costs could be generated. Another expert added that further difficulties exist when costing adaptation, since mitigation and adaptation are also linked through the fact that mitigation helps to reduce the costs of adaptation.

---

[17] World Bank. *Economics of Adaptation to Climate Change. Synthesis report.* Available at <http://documents.worldbank.org/curated/en/2010/01/16436675/economics-adaptation-climate-change-synthesis-report>.

[18] World Bank. *Monitoring Climate Finance and ODA*. Available at <http://siteresources.worldbank.org/ENVIRONMENT/Resources/DevCC3_Monitoring.pdf>.

91. One Party noted that **adaptation costs are not limited to developing countries**, stressing that in his country over 150 climate-related events had been recorded since 1980, with concomitant adaptation costs exceeding USD 1 billion (total adaptation costs exceeding USD 1 trillion). He requested clarification regarding the **uncertainties and limitations associated with top-down estimates of global adaptation costs**. An expert responded that opportunities for capitalizing on adaptation needs vary by country in both developed and developing regions, and that he could not explain why so many assessments focus on developing countries. He added that the cost uncertainties are due to the use of different models and impacts, as the models do not cover all sectors, especially human livelihoods and ecosystem protection. AR5 WGII therefore provided limited evidence, indicating a medium confidence level in relation to these costs.

92. Regarding **methodologies to quantify the adaptation benefit** of various options, an expert explained that the majority of the approaches in the literature examined benchmarks of desired adaptive capacity and measured the level of deviation from the benchmarks for specific sectors, interventions (e.g. sea level rise) and global goals, although no standardized methodologies exist to quantify these benefits. The same observation applies to costing adaptation, which typically focuses on what can be quantified, rather than on the ancillary or externality costs which tend to be excluded (see para. 89 above). Another expert commented that multiple overlapping methodologies, each focusing on one particular aspect only, have the benefit of providing overviews, but that no single methodology exists to cover all aspects as some adaptation benefits are not quantifiable. This is comparable to the fact that no methodology exists to quantify the overall benefits of development.

93. Responding to a question on **what is included in the portfolio of adaptation activities**, an expert indicated that AR5 WGII calls for adaptation to be addressed within the local context and that, in many cases, adaptation opportunities could arise in actions that may be different from traditional concepts of adaptation.

94. One Party requested clarification regarding the global amount of **investment in adaptation, the bodies investing** in adaptation and the attractive options for investment. Another Party asked why **investment in adaptation is seen as unattractive** in comparison with mitigation, as these investments could build reliance, for example in infrastructure, and should be seen as an opportunity, not as a cost. In response, an expert said that WGII concluded that there are attractive, synergistic opportunities for adaptation investment, especially in the context of the co-benefits with mitigation and sustainable development. He added that the world is moving into an era in which such investment opportunities can be created to address adaptation, mitigation and sustainable development needs. Another expert referred to the opportunities for adaptation identified in table 16.3 of AR5 WGII.

95. A Party commented on the **lack of communication between the Financial Mechanism under the Convention** (e.g. the Green Climate Fund) **and scientists** (e.g. the IPCC). He asked **how governments can carry out options identified in the UNFCCC process**, and how the IPCC could advise urban areas, communities and governments that are engaging in a non-climate-resilient development pathway. An expert underlined that, in order to move towards proactive adaptation, progress needs to be achieved as regards: the perception by policymakers and stakeholders that there is a risk; assessment of that risk; recognition that the risk needs to be acted upon and that the investment needed to respond thereto is justified; and capitalization on the opportunities for adaptation.

96. On the issue of the **difference between risk levels at 1.5 °C and 2 °C limits**, an expert answered that relatively few studies have explicitly considered the 1.5 °C limit, and that most of the adaptation literature does not generally identify a specific risk level for a specific temperature. In response to a follow-up question suggesting that more emphasis should be given to the 1.5 °C limit in the assessment process, an expert reiterated that all available literature on this temperature limit was considered in AR5 WGII. He added that risk-framing enables the analysis of a wide range of motivations for setting a target at various levels.

97. Some Parties commented that immediate emission reductions are required to reach low-stabilization pathways, illustrating that mitigation is the key to **avoiding dangerous anthropogenic interferences**; others pointed out the need for discussion regarding safe levels of impacts to achieve the objective of the Convention. An expert commented that if mitigation action is delayed, the opportunities to stay below the 2 °C limit will disappear. She added that the IPCC may not determine the 'safe' or 'dangerous' level, as this value judgment will be made by governments based on their perspectives of what is 'safe', for whom, for what, and according to which time frame. Another expert said that recognition of the associated safety issues was required, which

depends on the scale, frequency and severity of the impact, since the widespread consequences of climate change have already been witnessed. For example, from the perspective of a species, human individual or village that is currently facing those impacts, it has already reached an unsafe level. This shows the need to recognize that there is no 'guardrail' below which there are no impacts and that a more nuanced view should instead be fostered.

98. Regarding **pathways linking mitigation and adaptation**, a Party noted that mitigation can reduce adaptation needs, although the issue of quantification of adaptation benefits remains. Another Party said that prospects for climate-resilient pathways are fundamentally related to progress on mitigation, adding that poverty often prevents transition towards climate-resilient pathways. An expert noted that although mitigation is of benefit to adaptation, it cannot be quantified. Therefore, in implementing actions to address climate change, a holistic perspective should be used, together with an iterative risk management process and learning by doing, seeking 'no regrets' options, synergies and co-benefits, with a focus on those who are most vulnerable.

99. A Party commented that, according to figure 22, the **levels of additional risks for unique and threatened systems and due to extreme weather events are already moderate at 1 °C**. Noting that, for example, early warning systems and multipurpose-resistant houses could minimize loss of life, he asked for guidance to set policy priorities aimed at improving the resilience of the most affected people (e.g. minimizing the loss of life versus livelihoods versus ecosystem services). An expert responded that AR5 WGII identifies risks, and that policy priorities should be set by policymakers. Another expert replied that the establishment of early warning systems is a productive method only when used in an appropriate manner by combining knowledge and action, but will be ineffective if these two elements are not combined in a fair and just way.

100. Several questions arose regarding the definition of "**climate resilience**" and "**climate-resilient pathways**",[19] the difference between "**resilient" and "sustainable" development**, the extent to which a level of resilience can be seen as a target, and the likelihood of attaining sustainable development with the existing adaptation opportunities. As regards the ability to attain sustainable development, an expert said that this depends on the decisions to be made by policymakers. Regarding the difference between "resilient" and "sustainable" development, an expert explained that sustainable development includes "development" and has historically featured a strong economic component, while "resilience" is more independent from development – it can be related to development, but in a more flexible way. One Party commented that, before aiming for sustainable development, resilience must be built. Another expert underlined that the term "resilience" implies multiple synergies among approaches identified in the 'solution space' (figure 20) and has moved from natural sciences to social sciences. One expert emphasized that the scientific community is divided on this term, since its use varies from specific meanings in some disciplines, such as in ecology, to very vague interpretations in others. Further, in social sciences, "resilience" often focuses on the normative outcome of being resilient, thereby running the risk of masking the important process of actually reaching that desirable outcome.

101. Several questions were related to **international cooperation** on the transfer of technologies for adaptation to developing countries and adaptation in general. Experts stressed that while technology transfer is needed for some modern agricultural work, many low-cost, simple, efficient adaptation technologies are available, such as water-harvesting technology or clean cook stoves in rural households. Such technologies are not being fully deployed due to social, political and economic constraints, rather than due to technology transfer issues (see para. 106 below). Further, the role of social, political and organizational aspects should no longer be underestimated and should be appropriately addressed. In response to a follow-up question regarding how national adaptation planning could address some of these challenges, for instance in remote rural areas, an expert clarified that social and political aspects should be included in the national planning process in order to obtain a broader perspective of the risks, options and opportunities.

102. One Party asked for clarification regarding the **areas and issues that Parties should focus on in the context of international cooperation for adaptation** and the provision of means of implementation. An expert replied that this question relates more to the political, rather than the scientific, arena. Another expert underlined the importance of considering cooperation while bearing in mind the linkages among adaptation, mitigation and

---

[19] Climate-resilient pathways are sustainable-development trajectories that combine adaptation and mitigation to reduce climate change and its impacts. They include iterative processes to ensure that effective risk management can be implemented and sustained (summary for policymakers in the contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, page 28, section C.2).

sustainable development. She further noted several overlapping approaches for managing the risks of climate change, including by reducing vulnerability and exposure, adaptation (incremental and transformational) and transformation approaches (see table SPM.1). International cooperation is involved in many of these approaches (see para. 28 above).

103. Responding to a question on the **risks related to rural–urban interaction and the urbanization process** taking place in developing countries, an expert answered that this process will exacerbate risks such as a high mortality rate, injuries or loss of infrastructure, mainly due to the high population density resulting from urbanization and gaps in infrastructure. The disruption of an integrated service provision would affect larger areas and populations.

104. As regards the differences between **climate-smart and climate-resilient agriculture**, an expert commented that, in the past, the focus was on sustainable smart agriculture and the creation of optimal conditions for crops, for example in terms of soil moisture, but that in a changing climate optimal conditions can no longer be created. Thus, the main challenge for climate-smart agriculture is to become more resilient by using crops that can perform under suboptimal conditions, such as heat stress and drought. One Party asked about means of raising awareness of existing climate-smart agricultural technologies in rural settlements. An expert answered that adaptation planning should not be limited to technologies and infrastructure, but should also encompass social, political and institutional aspects if risks and opportunities are to be fully understood (see para. 101 above).

105. Regarding adaptation options to deal with **sea level rise**, including migration, one expert noted that the scale of what is currently perceived as adaptation may change in the long term following a sea level rise of many metres. Another expert responded that, today, one in eight people is mobile. People make mobility choices (ranging from voluntary mobility to forced relocation), taking into account food security, employment opportunities, livelihood security, and physical (natural) or conflict safety. One concern identified in AR5 WGII is that people are moving due to food security and climate-sensitive livelihoods. While most movements are currently internal, as the impacts of climate change unfold these could lead to undesirable displacement or relocation. Concerns are greater in areas with geographical constraints such as small islands. She underlined that, currently, four times as many people are displaced by extreme weather events and earthquakes than by conflicts.

106. On the issue of **key barriers to adaptation on the ground, and elements required to conduct better adaptation assessments and adaptation planning**, an expert noted that there is a lack of awareness and of communication among various ministries and a misunderstanding of risks, with some pointing to technology aspects and others drawing attention to social, political and institutional issues. At the same time, farmers, other local stakeholders and indigenous people often have a different understanding of risks at the local level. Another expert pointed to the considerable challenges involved in taking into account the wide range of factors determining risk in a system. As multiple stressors are involved, all of which may interact, they are likely to create circumstances that are very difficult to predict, regardless of the level of ambition of the research conducted. **Decision-making under uncertainty is therefore the primary mode of action for the foreseeable future**. Yet another expert underlined that while some constraints to adaptation need to be overcome both in developed and in developing countries, it should be recognized that in developing regions climate change is not the only pressing need. In the developed world, there is a greater focus on mainstreaming adaptation in national planning and awareness-raising, but fewer actions are focused on implementation. Another expert underlined that while engineering and technological adaptation options are the most commonly used, the importance of other types of adaptation, such as ecosystem-based behavioural changes or diversification of livelihoods, needs to be recognized.

107. In response to a question on examples of policies and measures that have successfully addressed **non-climatic stressors** and how inadequate planning can lead to maladaptation, an expert answered that climate is indirectly, rather than directly, linked to a number of risks, such as food insecurity or water competition, but that these interactions are difficult to assess. She illustrated how, in a multiple causal chain, climate change could exacerbate food production issues and lead to price shocks, and how adaptation measures could vary from food imports to food aid. Another expert noted that additional climate stressors may lead to the disappearance of landraces in agriculture, and thus reduce the number of adaptation options, as well as to increased vulnerability of deltas around cities. He added that there are many such confounding factors and alluded to the examples of water competition being problematic only for those consumers without a water tap or for poor people who are

pushed into areas with higher exposure to climatic impacts. He emphasized that all such phenomena could nevertheless be clearly connected to climate change.

108. Some Parties asked about the **positive and negative impacts of mitigation policies at the local level and the scope of the assessment of biofuels**. An expert clarified that literature in four areas was assessed to identify the implications for livelihoods of implementing mitigation policies (e.g. the clean development mechanism (CDM), REDD+, the voluntary carbon market, and the biofuels policy and its impact on other countries in terms of indirect land-use change). He distinguished between two types of literature assessed: one that focuses on the effectiveness of GHG emission reductions; and the other that focuses on the effect of these reductions on the poor, pointing to the threats posed by REDD+ to indigenous peoples and people who rely on protected forest areas. He further noted that voluntary carbon markets do not take into account local benefits, except for Gold Standard projects; extensive literature exists on the positive and negative effects of biofuel development from a poverty alleviation point of view; and that each of the four above-mentioned policies has proved to be a strong mechanism for global mitigation, but that few mechanisms have created benefits at the local level or in terms of poverty alleviation (see paras. 71 and 83 above and 115 below).

D. Part 3: setting the scene for the consideration of the contribution of Working Group III to the Fifth Assessment Report

1. Presentation by an expert

109. Part 3 of the meeting opened with a scene-setting presentation by Mr. Ottmar Edenhofer, Co-Chair of IPCC Working Group III (WGIII), on the overarching findings and new approaches of AR5 WGIII relevant to the two themes of the 2013–2015 review. He explained that WGIII explored the full 'solution space' in order to inform decision makers on the various possible emission pathways, their underlying costs, risks and opportunities.

110. On the issue of **trends in stocks and flows of GHG emissions**, Mr. Edenhofer stressed that GHG emissions growth has accelerated despite mitigation efforts and the global economic crisis, and that emissions growth between 2000 and 2010 was greater than in any of the previous three decades (figure 31). Regarding the historical perspectives of anthropogenic GHG emissions, he noted that about half of the cumulative anthropogenic CO_2 emissions between 1750 and 2010 occurred in the last 40 years (figure 32). He underlined that, for the first time, the IPCC presented the underlying uncertainties in the estimated historical emissions in more detail.

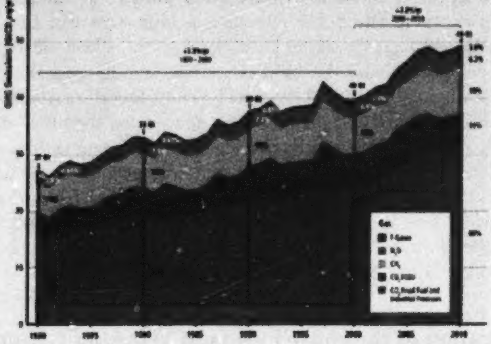
111. With respect to **regional patterns of GHG emissions**, Mr. Edenhofer explained that these patterns are shifting along with structural changes in the world economy. Upper middle-income countries are replicating the emissions trajectories of upper-income countries, and the industrial and energy sectors play the most important part in the increase in emissions. The land-use sector is not as significant in high- and middle-income countries as in low-income countries, where it is the main emission source (figure 33).[20] Income is the most important driver of GHG emissions at the global level, followed by population growth. Emission growth driven by these two factors has overtaken emission reductions from improvements in energy efficiency. The long-lasting trend in gradual decarbonization has been reversed during the last decade, mainly owing to an increased use of coal in the power sector (figure 34).

---

[20] The *structure* and dynamic of $^{\text{emissions}}$ data for the upper middle-income group indicates limited leapfrogging (see para. 183 above).

Figure 31

Total annual anthropogenic greenhouse gas emissions by groups of gases, 1970–2010

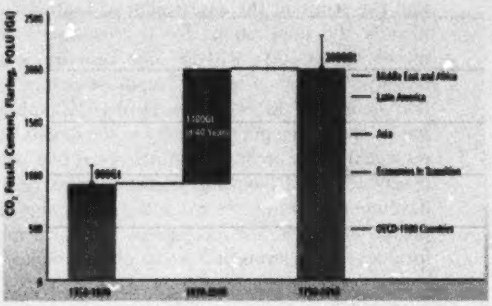


Source: Summary for policymakers in the contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.1. The figure illustrates that emission growth has accelerated in the last decade.

Abbreviation: FOLU = forestry and other land use.

Figure 32

Cumulative anthropogenic CO_2 emissions between 1750 and 2010



Source: Simplified version of figure TS.2 from the technical summary in the contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (see slide 7 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_edenhofer_sbsta_sed_wg3_overview.pdf>. The figure illustrates the historical cumulative anthropogenic CO_2 emissions per region and group of countries between 1970 and 2010.

Abbreviation: FOLU = forestry and other land use.

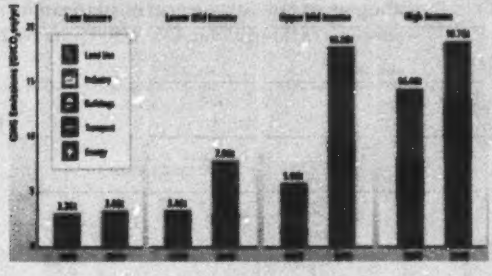
112. Regarding the **action required to limit warming to 2 °C**, Mr. Edenhofer underscored the substantial technological, economic and institutional requirements, in particular in the energy sector and potentially in land use. Without additional mitigation, the global mean surface temperature is projected to increase by 3.7–4.8 °C over the course of the twenty-first century (based on median transient climate response estimate; the range (90% percentile) is 2.5°C to 7.8°C when adding climate uncertainty). The stabilization of anthropogenic concentrations at low levels requires a move away from the baseline, regardless of the global mitigation goal. Even a 3 °C limit requires a substantial reduction in GHG emissions and a fundamental transformation of the energy system. A 2 °C limit requires a larger emissions reduction in the short to medium term, and negative emissions in the second half of the twenty-first century. Both require substantial scaling-up of low-carbon energy. Important aspects of risks of mitigation are therefore associated with the scaling-up of low-carbon technologies (approximately 300 per cent above current levels by 2050 for a 2 °C limit).

113. **Delaying mitigation** increases the difficulty and narrows the options for limiting warming to 2 °C. Immediate mitigation action, which is consistent with a cost-effective emissions pathway to achieve the 2 °C target, would imply a reduction in emissions of about 3 per cent annually between 2030 and 2050, an unprecedented emission reduction rate in economic history. On the other hand, delaying action would imply even larger emission reductions in the future (about 6 per cent per year between 2030 and 2050), at higher costs and with higher risks (figure 36). Mr. Edenhofer added that the current Cancun pledges are insufficient to achieve the long-term global goal.

114. With regard to **the 1.5 °C target**, scientific evidence remains limited because of the limited number of studies on this limit for global warming and the absence of multi-model comparison studies that analyze the relevant pathways more systematically. Available scenarios in these existing studies are characterized by a temperature overshoot and large-scale application of CO_2 removal technologies; immediate mitigation action; a rapid scaling-up of the full set of technologies; and development along a low-energy demand pathway.

Figure 33

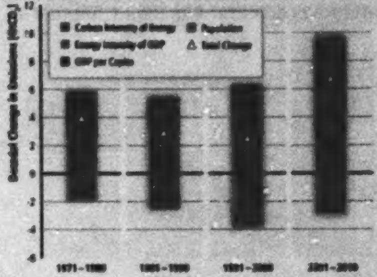
Greenhouse gas emissions by country group and economic sector



Source: Slide 8 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_edenhofer_sbsta_sed_wg3_overview.pdf>.

Figure 34

Decomposition of the change in total global CO_2 emissions from fossil-fuel combustion



Source: Summary for policymakers in the contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.3.

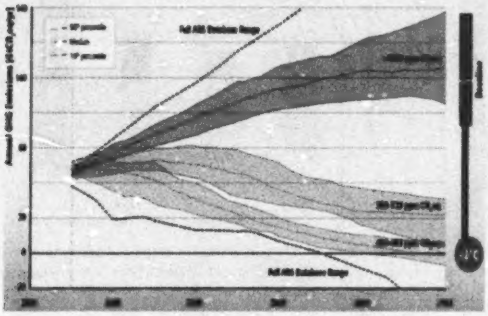
Abbreviation: GDP = gross domestic product.

115. Regarding **mitigation costs**, Mr. Edenhofer noted that available estimates vary widely, but do not significantly affect global GDP growth. He explained that the uncertainties surrounding the global cost estimates are due to the wide range of mitigation costs, which are partially due to the differences in projected low-carbon technology uptake in the various models. While underlining that global costs rise with the level of ambition of the mitigation goal, he pointed out that mitigation action would delay, but not sacrifice, economic growth. Mitigation consistent with the 2° C limit involves annualized reduction in consumption growth of 0.04 to 0.14 (median: 0.06) percentage points over the century relative to annualized consumption growth from the baseline that is between 1.6 and 3 per cent per year. He added that the availability of technologies seriously affects mitigation costs. Without carbon dioxide capture and storage (CCS) and with limited availability of bioenergy, the mitigation costs would increase markedly in the medium term. Specifically, if CCS is unavailable, the costs of staying below the 2 °C limit (with a larger than 50 per cent chance) will increase by approximately 140 per cent relative to default technology assumptions, and if bioenergy is limited, the costs will increase by approximately 70 per cent. The combination of bioenergy and CCS (BECCS) in the models is also important for negative emissions to be achieved in the second half of the twenty-first century (figure 37) (see paras. 71, 83 and 108 above). Projections in many models could not stay below 2 °C by 2100 if additional mitigation is considerably delayed or if the availability of key technologies, such as bioenergy, CCS, and their combination (BECCS), is limited.

116. On the issue of **options to reduce GHG emissions**, he emphasized that mitigation scenarios indicate the necessity to fully decarbonize energy, but that there is flexibility in that process. The scale of energy demand reductions is important as it will determine the level of flexibility in decarbonizing energy supply and the associated ability to hedge against supply-side risks, avoid infrastructure lock-in, and determine the co-benefits of mitigation. Regarding **mitigation co-benefits**, he pointed to positive side effects of mitigation, in particular for human health, but also for other societal goals. For example, low stabilization scenarios carry substantial health benefits through reductions of emissions of black carbon. At the same time he explained the difficulty of translating such co-benefits into net welfare gains (figure 38).

Figure 35

Greenhouse gas emission pathways, 2000–2100: scenarios from the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

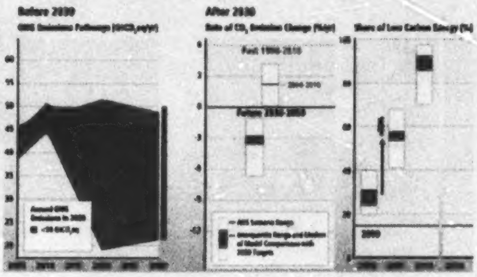


Source: Slide 16 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change (IPCC)), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_edenhofer_sbsta_sed_wg3_overview.pdf>. The figure shows some emission pathway scenarios as used in the IPCC Fifth Assessment Report.

Abbreviations: CO_2 eq = CO_2 equivalent, AR5 = Fifth Assessment Report of IPCC

Figure 36

The implications of greenhouse gas emission levels in 2030 for the rate of CO_2 emission reductions and scaling-up of low-carbon energy (mitigation scenarios reaching about 450 to 500 ppm by 2100)



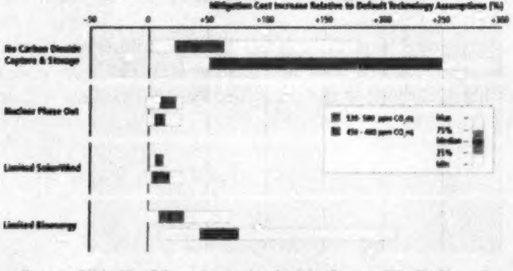
Source: Slide 20 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_edenhofer_sbsta_sed_wg3_overview.pdf>. The figure summarizes the near- and mid-term mitigation needed to limit greenhouse gas concentrations to between 450 and 500 ppm CO_2 eq by 2100.

Abbreviations: GHG = greenhouse gas, AR5 = Fifth Assessment Report of IPCC

117. With regard to **policies that have attracted the greatest interest,** Mr. Edenhofer underlined that all scenarios considered in AR5 WGIII identified the pricing of CO_2 as a necessary condition to achieving the long-term global goal, in conjunction with other policies. Substantial reductions in GHG emissions would require large changes in annual investment flows and in investment policies, which would lead to an adjustment of global investment in the energy sector (figure 55). Such policies would require a credible CO_2 price signal. While recognizing the increase in available literature since AR4 on policies designed to integrate multiple objectives, increase co-benefits and reduce adverse side effects (e.g. government provision of public goods and services, regulatory approaches, economic instruments and information programmes), he called for future research and ex-post evaluation of such policies that are already in place; and the provision of information to stakeholders on the appropriate way of combining the available policy instruments, so that they effectively complement each other.

Figure 37

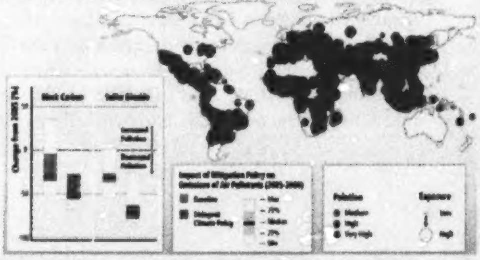
Availability of technologies and mitigation costs



Source: Slide 27 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_edenhofer_sbsta_sed_wg3_overview.pdf>. The figure shows the dependence of mitigation costs on some mitigation technologies.

Figure 38

Health co-benefits of mitigation

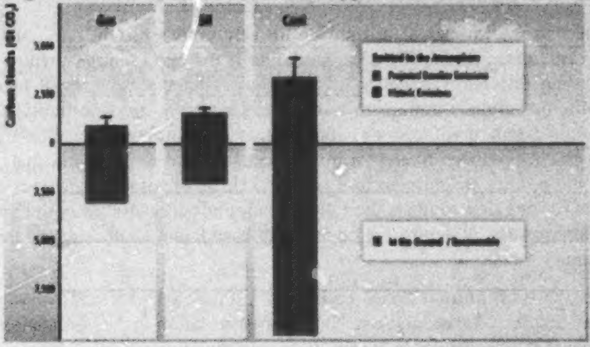


Source: Slide 32 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_edenhofer_sbsta_sed_wg3_overview.pdf>. The figure illustrates some of the co-benefits of mitigation.

118. In concluding, Mr. Edenhofer stressed that **there is far more carbon in the ground than can be emitted, given the limited disposal space in the atmosphere**, which is why low-stabilization pathways are so demanding in terms of technological and institutional requirements (figure 39).

Figure 39

Levels of carbon in the ground and emitted for different types of fossil fuels



Source: Slide 41 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_edenhofer_sbsta_sed_wg3_overview.pdf>. The figure shows the amount of carbon that is estimated to be in the ground and the amount that has already been emitted to the atmosphere.

2. General discussion

119. The ensuing discussion was guided by the following questions:

(a) What does AR5 WGIII tell us about the mitigation action required to limit global warming to 2 °C or 1.5 °C, the relationship between mitigation and other climate change responses such as adaptation, and valuations, including expert value judgment?

(b) How reliable are the projections of emission pathways and how can they be used for decision-making at the global level?

(c) What are the options to reduce emissions through mitigation and low-carbon development?

120. A Party asked **how much CCS and bioenergy deployment could be performed at scale**, and if such an uptake is realistic in the long term. The expert explained that the WGIII findings on how much CCS, BECCS and bioenergy would be needed are based on the requirement in ambitious scenarios to have negative emissions in the second half of the twenty-first century to achieve low stabilization targets. He pointed to an appendix to the agriculture, forestry and other land use (AFOLU) chapter on bioenergy that highlights the diversity of opinions on this question and outlines the underlying risks of generating large amounts of bioenergy for food security and prices, as well as for biodiversity. He stressed the need for policymakers to consider the risks and benefits of using these technologies. The expert added that CCS and bioenergy are low-cost options for reducing emissions, but to reduce the associated risks, such options should be accompanied by an integrative institutional framework that would take into account the competition for land, notably a comprehensive carbon-pricing mechanism that covers all sectors, including land use.

121. Responding to a question raised by a Party regarding the **window of opportunity in relation to a 1.5 °C and 2 °C temperature rise**, the expert said that in AR5 WGIII this window is driven by the speed of the scaling-up of low-carbon technologies and the level of risk of such scaling-up, rather than by atmospheric physics, which is only the boundary condition. Scenarios consistent with a temperature rise of 1.5 °C combine all of the most ambitious features we know from the literature on the 2 °C limit. He added that mitigation action over the next decade will determine the required mitigation action after 2030 and its cost. The risk related to the scaling-up of low-carbon technologies becomes higher when mitigation is delayed. In response to a question on the additional risks that would be created by an overshoot in emissions and temperature, the expert said that overshoot is a typical feature of low stabilization scenarios, all of which therefore have risks.

122. Regarding the **global carbon budget**, a Party referred to figure 38 and asked how much CO_2 can still be emitted to achieve the long-term global goal. The expert indicated that the global carbon budget specified in AR5 WGIII is broadly consistent with that of AR5 WGI, but that a broader range of mitigation pathways have been considered in the former. He added that the limiting factor in the twenty-first century is not the availability of fossil fuels (figure 39), but rather the limited disposal space in the atmosphere, which is why climate change should be understood as a global common problem.

123. With respect to the **impact of mitigation on economic growth**, one Party asked how the reduction in consumption was calculated by the IPCC, in particular if the opportunities created by shifts in investments and the reduced spending on energy because of increased efficiency have been taken into account. The expert underlined that although climate mitigation can indeed be seen as an opportunity cost since it will reduce future consumption to some extent, it will also provide opportunities for new investments. He further explained that, for example, carbon pricing reduces return on investment in some sectors, and that, although the reallocation of budget creates opportunities in other sectors (figure 55), this reallocation comes at a cost. He added that two types of models exist: one that assumes the full utilization of all resources in the long term (i.e. without any idle resources and, consequently, with positive opportunity costs); and another where there are idle resources leading to smaller opportunity costs.

124. As regards the **total annual GHG emissions**, a Party asked if removals by sinks were included in the figures. The expert explained that land-use change, deforestation and afforestation were taken into account by the models, adding that in scenarios where CCS is not available, AFOLU becomes more important and more afforestation is needed.[21] Low stabilization pathways therefore depend not only on changes in energy supply, but also on changes in the AFOLU sector (figure 44).

125. Regarding the **use by the SED of information not included in the AR5 WGIII summary for policymakers** (SPM), several Parties opposed such use, in particular in relation to information on the categorization of countries based on income levels, and reminded participants that several countries also opposed the inclusion of this information in AR5 WGIII. They noted that the categorization of countries is not in line with the provisions of the Convention, and asked if such information is available in AR5 WGIII for Parties included in Annex I to the Convention and Parties not included in Annex I to the Convention. Other Parties welcomed the use of this information by the SED. The expert replied that deleted information from the SPM is available in the technical summary and underlying report, adding that the IPCC presents historical and factual data, such as cumulative, production-based and consumption-based emissions, from different perspectives, including according to income categories, so that policymakers can explore the issue from different perspectives.

126. On the issue of **metrics**, one Party commented that the global temperature potential (GTP) metric is better suited to carrying out an assessment of certain aspects of climate change only and asked about the importance of using GTP to guide mitigation policies, taking into account the fact that Parties have agreed on a temperature-related long-term global goal. The expert responded that global warming potential (GWP), GTP, and global damage potential were discussed by WGIII, and that GWP is "relatively robust", taking into consideration the fact that costs and mitigation strategies do not differ greatly if other metrics are used and the required data are available.

127. Regarding **fossil-fuel subsidies**, a Party asked about the emission reductions that would be achieved by their removal. The expert said the WGIII did not assess the impact of removing such subsidies, but stressed that it would require distinguishing between subsidy removal scenarios both with or without a carbon price.

---

[21] See the summary for policymakers in AR5 WGIII, figure SPM.7, available at <http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf>.

E. Part 3 – theme 1: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention based on the contribution of Working Group III to the Fifth Assessment Report

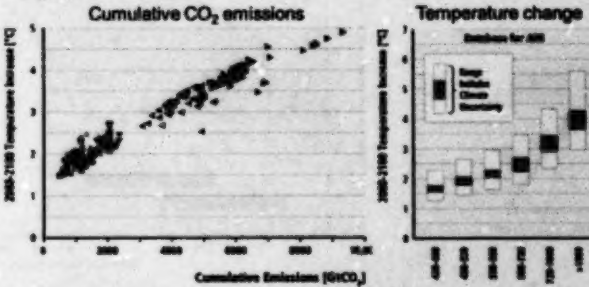
1. Presentations by experts

128. Mr. Volker Krey (IPCC) made a presentation on **transformation pathways and limiting warming to specific levels, notably a global mean warming of 2 °C or 1.5 °C relative to pre-industrial levels.** He explained that the WGIII experts collected approximately 1,200 scenarios from existing literature in an "AR5 scenario database" to assess transformation pathways, and their costs and mitigation implications. The scenarios were then categorized based on their CO_2 eq concentration in order to link them with the various RCPs assessed by WGI. Around 150–200 pathways corresponding to a concentration of 400 ppm CO_2 eq by 2100 are consistent with RCP2.6. While noting the wide range of scenarios, he said that their common element is the stringent emissions reduction required to limit warming below 2 °C.

129. Noting that, to achieve low levels of temperature change, cumulative CO_2 emissions must be limited, he indicated that the **emissions budget for staying below the 2 °C limit** is about 600–1,200 Gt CO_2 for the period 2011–2100, and historical emissions for the period 1870–2011 are about 1,850 Gt CO_2 (figure 40). Figure 40 also illustrates the range of temperature increase by the end of the twenty-first century for the six ranges of CO_2 eq concentrations used to categorize the scenarios in AR5 WGIII.

Figure 40

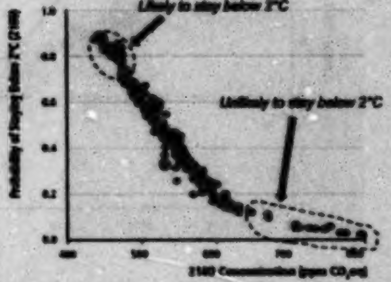
Relationship between cumulative CO_2 emissions and global temperature change



Source: Slide 5 of the presentation by Mr. Volker Krey (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_krey_vuuren_sed3.pdf>. The figure illustrates how global warming is related to cumulative CO_2 emissions.

Figure 41

Probabilistic interpretation of the 2 °C warming scenarios



Source: Slide 6 of the presentation by Mr. Volker Krey (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_krey_vuuren_sed3.pdf>. The figure shows the probability of staying below a 2°C limit as determined by atmospheric CO_2 eq concentrations.

130. Mr. Krey underlined that a major advancement since AR4 is the probabilistic interpretation of the scenario literature, which shows the relationship between the atmospheric concentration of CO_2 eq in 2100 and the probability of staying under the 2 °C limit (figure 41). Scenarios in the lowest concentration category (430–480 ppm) have at least 66 per cent probability of staying below a 2 °C warming. For a concentration of 600 ppm CO_2 eq, which corresponds to the range of scenarios for RCP4.5, the likelihood of staying under the 2 °C limit is below 20 per cent. Therefore, to better cover the ranges of possible concentrations, two additional categories of scenarios were considered in AR5 WGIII in between RCP2.6 and RCP4.5, corresponding to concentrations ranging between 480–530 ppm (dark blue in the figure) and 530–580 ppm (yellow in the figure).

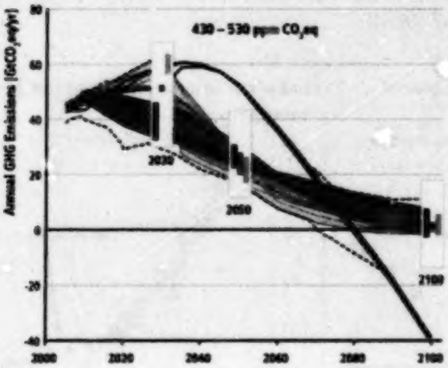
131. Regarding the **relationship between global GHG emissions and the likelihood of different temperature limits**, he showed how atmospheric concentration levels are linked to emission budgets and reductions (in 2050 and 2100), and the expert assessment of the likelihood of temperature change (see table SPM.1). Scenarios where atmospheric concentration levels of about 450 ppm CO_2 eq are reached by 2100, consistent with a likely probability of keeping temperature change below 2 °C, are characterized by emission

reductions of 40–70 per cent below 2010 levels by 2050 and by reductions of 80–120 per cent by the end of the twenty-first century. He stressed the interdependence between emission levels in 2050 and 2100 for scenarios in a given category due to the cumulative budget constraint – a high-end emissions level in 2050 would require a low-end emissions level in 2100 and the use of CO_2 reduction technologies such as BECCS.

132. As regards **concentration overshoot**, Mr. Krey underlined that temporary overshooting is an integral part of all pathways that lead to a 2 °C warming (430–480 ppm category), and that this overshoot is more pronounced for the 1.5 °C limit (in fact, 1.5 °C compatible pathways typically involve temperature overshoot). He added that overshooting was explicitly considered in the 480–530 ppm and 530–580 ppm scenarios. In addition, he noted that only a few scenarios, based on two models, have examined pathways with a likelihood of staying below a 1.5 °C warming (less than 430 ppm CO_2 eq in 2100), and were not included in the quantitative analysis of the scenario literature in the report as they would have distorted the overall picture by introducing some model bias.[22] For limiting warming below 3 °C instead of 2 °C, the cumulative CO_2 budgets is two to three times higher, but emission levels in 2100 of around zero will still be required for such scenarios.

Figure 42

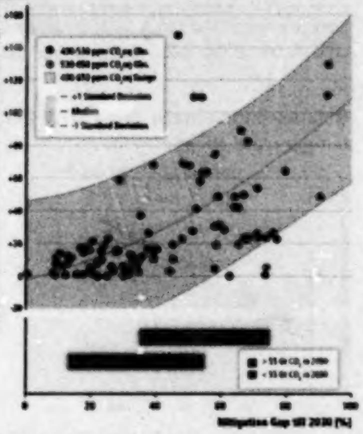
Possible trajectories to stay below a 2 °C limit



Source: Slide 8 of the presentation by Mr. Volker Krey (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_krey_vuuren_sed3.pdf>. The figure illustrates that there are several emission pathways to stay under a 2 °C limit, but with varying subsequent requirements for CO_2 removal technologies (e.g. a combination of bioenergy and carbon dioxide capture and storage).

Figure 43

Increased mitigation costs resulting from delayed mitigation



Source: Slide 15 of the presentation by Mr. Volker Krey (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_krey_vuuren_sed3.pdf>. The figure shows that late mitigation action increases the mitigation costs and deviates from an optimal, cost-effective pathway.

133. Regarding the **role of CO_2 removal technologies**, different trajectories are possible to reach the same target, but scenarios where early mitigation action is not taken rely heavily on negative emissions in the second half of the twenty-first century through the use of bioenergy and CCS (figure 42). The Cancun pledges are not consistent with the goal of staying under the 2 °C limit in a cost-effective manner. He stressed that mitigation costs increase if mitigation action is delayed (figure 43) or if the availability of low-carbon technologies is limited (figure 45), noting that many models were unable to produce 2 °C pathways if CCS and bioenergy technologies were not available. He added that, while mitigation costs vary widely, they are relatively modest compared to overall economic growth (see also table SPM.2). Figure 43 illustrates the increase in mitigation costs if mitigation action is delayed as a function of the mitigation gap until 2030.

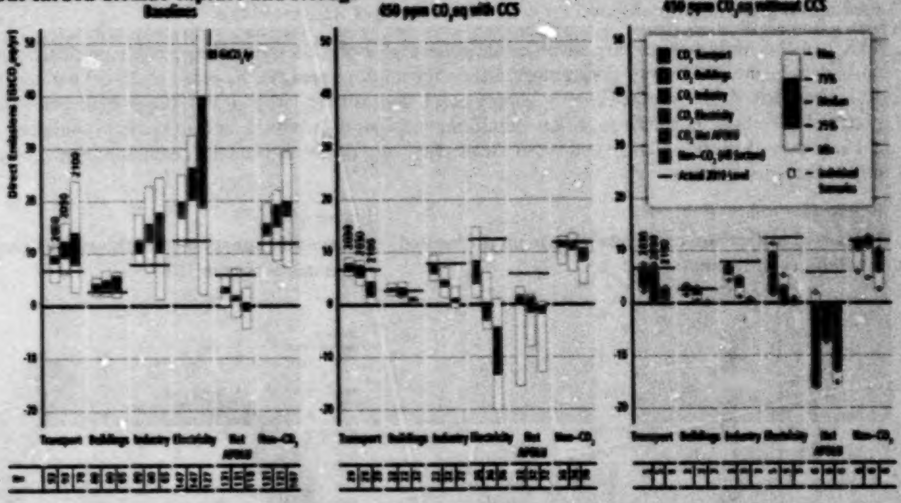
---

[22] See the summary for policymakers in AR5 WGIII, table SPM.1, available at <http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf>.

134. On the issue of **sectoral emissions**, he pointed to a projected increase in emissions in all sectors according to the baseline scenarios, except for the AFOLU sector. Mitigation action in one sector depends on such action in another sector, as well as the availability of CCS and bioenergy. For example, 450 ppm CO_2 eq scenarios without CCS rely on large-scale afforestation. Some scenarios with CCS rely on negative emissions in the electricity sector that allows other sectors, such as transport, to modestly increase emissions by 2030 compared with current levels and to reduce their emissions at a slower pace thereafter (figure 44).

Figure 44

Direct sectoral CO_2 and non-CO_2 greenhouse gas emissions in baseline and mitigation scenarios with and without carbon dioxide capture and storage



Source: Summary for policymakers in the contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.7. The figure illustrates the effects of the availability of carbon dioxide capture and storage on greenhouse gas emissions in various sectors.

Abbreviation: AFOLU = agriculture forestry and other land use.

135. Ms. Joyashree Roy (IPCC) made a presentation on **sectoral and cross-sectoral mitigation**. She highlighted that GHG **emissions continue to rise in the energy supply and energy end-use sectors**, implying the need for widespread mitigation actions in order to achieve low stabilization scenarios. Almost 80 per cent of the GHG emissions growth between 2000 and 2010 comes from the energy supply and industrial sectors (figure 46). She indicated that the IPCC identified a range of low-carbon power-generating technologies that are currently commercially available or at the pre-commercial stage and estimated the specific direct and lifecycle emissions for such technologies, as well as the levelized cost of electricity, underlining that some are already cost-competitive in comparison with conventional fossil-fuel technologies.[23]

136. Regarding **energy supply mitigation options**, she noted that in the majority of low-stabilization scenarios, the share of **low-carbon electricity supply** (comprising renewable energy, nuclear energy and CCS) increases from the current level of approximately 30 per cent to over 80 per cent by 2050, and fossil-fuel power generation without CCS is almost entirely phased out by 2100. She added that in mitigation scenarios in which CO_2 eq concentration levels of 450 ppm are reached by 2100, **natural gas power generation without CCS** acts as a bridging technology, peaking before, and reaching below, current levels by 2050, and declining further in the second half of the twenty-first century. Although the energy sector was the largest GHG emitter in 2010, the importance of the industry and buildings sectors rises as indirect emissions are accounted for (figure 46).

137. With respect to the **industrial sector**, Ms. Roy emphasized that global production of minerals and manufactured products is growing steadily and driving GHG emissions. She outlined five main options for

---

[23] See also the technical summary in AR5 WGIII, figure TS.19, available at <http://www.ipcc.ch/report/ar5/wg3>.

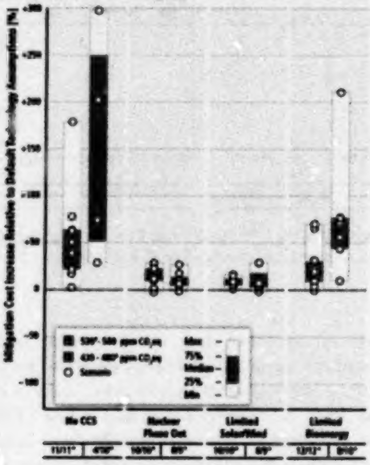
mitigating end-use sector-specific emissions: energy efficiency; emissions efficiency (e.g. switching to a non-fossil fuel electricity supply or cement production with CCS); material efficiency in manufacturing (e.g. using old steel structures without melting) or product design (e.g. lightweight car design); product-service efficiency (e.g. car-sharing or increased building occupancy); and service-demand reduction (e.g. switching from private to public transport).

138. Using the example of the steel sector, she highlighted that significant **mitigation potentials exist in various costs ranges**, including cost-effective measures. She added that attractive mitigation potentials exist in all areas and described these potentials for various sectors (figure 47).[24] In the waste sector, emissions have doubled since 1970 and mitigation measures could follow the waste hierarchy, starting with preventative measures and ending with disposal for which the cost ranges were provided.

139. In the **buildings sector**, advances in technologies and lifestyle change can significantly reduce GHG emissions by the mid twenty-first century. Efficiency improvements in the range of 25–30 per cent are available at lower costs than marginal energy supply costs. Retrofitting, with a 50–90 per cent emissions reduction potential for existing buildings, offers significant mitigation potential, and low-energy building codes could avoid lock-in. Lifestyle change and better architecture can further reduce GHG emissions in the near term to the mid twenty-first century.

Figure 45

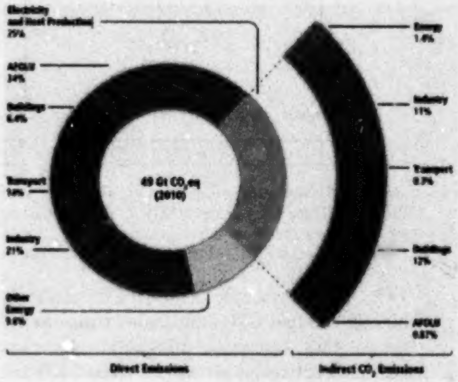
Increased mitigation costs resulting from the limited availability of technologies



Source: Slide 15 of the presentation by Mr. Volker Krey (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_krey_vuuren_sed3.pdf>. The figure shows the increase in mitigation costs if low-carbon technologies are not freely available.

Figure 46

Total anthropogenic greenhouse gas emissions by economic sector in 2010



Source: Summary for policymakers in the contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.2. The figure shows the current contributions to emissions by sector.

Abbreviation: AFOLU = agriculture forestry and other land use.

140. In the **transport sector**, she noted that emissions will grow until 2100 according to the 'business as usual' scenario, with a faster rate for passenger transport than freight transport. She detailed the possible mitigation options with various costs for passenger and freight transport,[25] noting that some of these technologies currently have higher levelized costs than the conserved carbon, indicating that policies are needed for their deployment. Regarding **human settlements**, infrastructure and spatial planning, she stressed that urban areas account for more than half of global primary energy use and energy-related CO_2 emissions, and that the largest

---

[24] See also the technical summary in AR5 WGIII, figure TS.27, available at <http://www.ipcc.ch/report/ar5/wg3>.

[25] See also the technical summary in AR5 WGIII, figures TS.21 and TS.22, available at <http://www.ipcc.ch/report/ar5/wg3>.

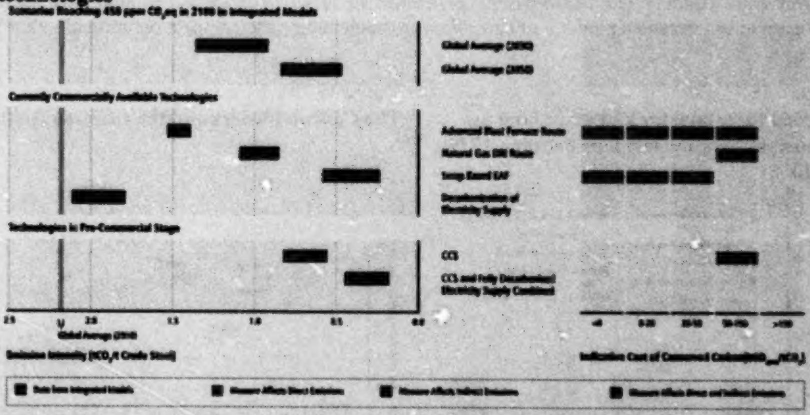
opportunities for future urban GHG emissions reduction might be found in rapidly urbanizing countries where urban form and infrastructure are not locked-in. However, she warned that governance, as well as technical, financial and institutional capacities, is often limited in such countries. In addition, significant differences exist in per capita GHG emissions between cities within a single country.

141. Regarding **AFOLU**, Ms. Roy said that this unique sector accounts for 24 per cent of total anthropogenic GHG emissions and is the only sector in which net emissions fell in the last decade. She specified that while agricultural non-CO_2 GHG emissions increased, net CO_2 emissions fell, mainly due to decreasing deforestation and increased afforestation rates (figure 48).[26] She outlined the possible economic mitigation options in the AFOLU sector, including in forestry, such as the restoration of cultivated organic soils and grazing land management, stressing the need to consider both demand- and supply-side measures.[27]

142. Ms. Roy underlined that most **systemic approaches to mitigation across the economy are expected to be environmentally and cost-effective.** Efforts in one sector determine mitigation efforts in others, thereby highlighting the importance of negative emission options in some sectors in ambitious mitigation scenarios (see para. 133 above). Reducing energy demand through efficiency enhancements and behavioural changes are key mitigation strategies.

Figure 47

Indicative CO_2 emission intensities and the levelized cost of conserved carbon for various steel production practices/technologies



Source: Slide 13 of the presentation by Mr. Joyashree Roy (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_roy_sed3_final.pdf>. The figure illustrates the mitigation potentials in a specific sector.

Abbreviations: CCS = carbon capture and storage; EAF = electric arc furnace.

143. In concluding, she stated that the wide application of available best-practice low-GHG technologies could lead to substantial emission reductions, and that financial and institutional barriers may be overcome by packages of complementary policies that take regional specificities into account.

144. Mr. Axel Michaelowa (IPCC) addressed the **performance of climate policies and climate finance at the international, regional and national levels.** He stressed that climate change mitigation is a global public good and thus requires international cooperation. Regarding the performance of national climate policy, he noted that from 2007 to 2012, the share of global emissions in countries with such policies rose from 45 to 67 per cent and, thus far, these policies have not significantly influenced the emissions trend. Consequently, there is a need to learn from successful examples at all policy levels to address the mitigation challenge.

---

[26] See also AR5 WGIII, figure 11.2(A), available at <http://www.ipcc.ch/report/ar5/wg3>.

[27] See also the technical summary in AR5 WGIII, figure TS.31, available at <http://www.ipcc.ch/report/ar5/wg3/>.

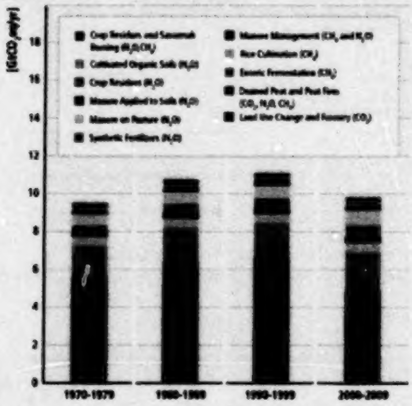
145. Regarding the performance of **international climate policy**, while stressing that the UNFCCC regime is the only platform with broad legitimacy, he noted increased cooperation outside the UNFCCC, which, with the exception of the Montreal Protocol, has not led to significant emissions reductions. Although the Kyoto Protocol commitments have been reached, benefiting from changes in countries with economies in transition and the use of market-based mechanisms which mobilized low-cost mitigation, the additionality of these measures is debatable and the Kyoto Protocol has been viewed as less successful than envisaged. As regards the Cancun pledges, he stated that they are more consistent with a 3 °C temperature increase than with a 2 °C temperature increase by 2100, underlining that their impact could differ substantially depending on their interpretation (figure 49).

146. With respect to the performance of **policies at the subnational level**, Mr. Michaelowa noted the lack of evidence on the contribution to mitigation of agreements between non-State actors, highlighting the difficulties of differentiating between subnational and national efforts. With regard to the private sector, he noted that private–public partnerships work in the presence of a strong signal from government regulators; private-sector initiatives in isolation are not successful in driving down emissions; and emission reductions are driven by public policies.

147. **Regional cooperation**, which is a new chapter in the AR5, has had only a limited positive impact on mitigation, even in areas of regional integration such as the European Union, due to unexpected economic shocks; uncertainty about the long-term emission reduction targets; and interaction with other policy instruments. Binding regulation-based approaches in areas of deep integration have had some impact on mitigation, but despite a plethora of agreements on technology, their impact on mitigation has been negligible to date.

Figure 48

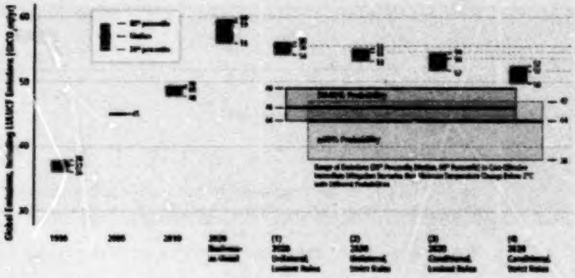
Agriculture, forestry and other land use emissions over the last four decades, 1970–2010



Source: Slide 22 of the presentation by Ms. Joyashree Roy (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_roy_sed3_final.pdf>. The figure depicts the level of emissions over the last four decades for the agriculture, forestry and land use sector, in which emissions have decreased.

Figure 49

The Cancun pledges and the emissions pathway



Source: Slide 4 of the presentation by Mr. Axel Michaelowa (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/4_michaelowa_sed3.pdf>. The figure shows that the estimated effectiveness of Cancun pledges depends to a large extent on how they are interpreted.

148. Regarding **national policies**, he noted that the issue of co-benefits, such as energy security and local air quality, has gained increased attention, but remains to be assessed, in particular at the desegregated level. He outlined the assessment of the performance of various instruments, stressing that emission taxes are found to be more effective than voluntary mitigation. Sectoral policies are easier to implement than economy-wide policies. Some direct regulation, especially efficiency standards for buildings, cars and household appliances, is cost-

effective. Emissions trading systems introduced to date suffer from caps that are too lenient and have thus experienced price decreases. Emission taxes have been effective and can be applied in conjunction with other instruments, while the efficiency of technology policies is unclear.

149. As to the performance of **climate finance**, he indicated that total public and private **climate finance investments** are estimated at USD 343–385 billion per annum, with an almost even distribution among developed and developing countries, with 95 per cent of the investments directed at mitigation. Public climate finance is estimated at USD 35–49 billion per annum, but robust information on levels of private-sector flows from developed to developing countries is very scarce. In addition, dedicated financial instruments to decrease the risks of low-carbon technologies (e.g. credit enhancement and insurance, guarantees or finance in local currency) have rarely been applied in the context of mitigation, and performance assessment is therefore limited.

2. General discussion

150. The ensuing discussion was guided by the following questions:

(a) What will the increase in temperature be by the end of the twenty-first century without additional mitigation compared with the 'business as usual' scenario, and how do the AR5 WGIII findings on this matter compare with the findings of WGI?

(b) What mitigation pathways will limit global warming below 2 °C or 1.5 °C? What changes in emissions are required to stay below a 2 °C or 1.5 °C increase in global mean temperature relative to pre-industrial levels?

(c) What is the cost associated with the mitigation pathways for various levels of global mean warming and what will be the consequences of limited access to technologies or of delaying mitigation?

(d) What are the sector-specific emission trends, mitigation potentials, technologies and investment patterns? How do mitigation efforts in one sector influence mitigation efforts in others?

(e) Based on technology development trends, what are the low-cost abatement opportunities that can be pursued in the near term? What are the higher cost opportunities that are not yet commercially viable but could hold significant abatement potential over the longer term?

(f) What policies have attracted the greatest attention? How can we maximize climate policy co-benefits and reduce adverse side effects?

(g) What is the role of international climate change cooperation? What role can subnational actors play (e.g. the private sector, cities and sub-national authorities) in reaching the long-term global goal and creating enabling environments?

151. One Party asked whether, for the **1.5 °C limit**, the assumption was maintaining this temperature increase **for the entire twenty-first century or by the end of the century**. An expert explained that the probabilities specified in AR5 WGIII correspond to staying below a given temperature limit throughout the century. He added that there is no scenario in the data set where the global mean temperature is likely to remain below 1.5 °C throughout the century and only a few scenarios where the global mean temperature is more likely than not to remain below this limit in 2100. Another Party noted that for the 430–480 ppm category of scenarios with overshoot of less than 0.4 W/m^2 the projected temperature increase by 2100 is between 1.5 °C and 1.7 °C and, hence, the low part of these emission scenarios has a 50 per cent probability of limiting global warming below 1.5 °C.[28] The Party then asked about the required technologies and their scaling-up, the technology portfolio and the costs related to achieving these scenarios for the category with CO_2 concentration levels below 430 ppm, and how they compare with scenarios in the 430–480 ppm category that are more consistent with the 2 °C limit. The expert stated that the required technologies are the same as for the 2 °C pathway, the only difference being that they need to be deployed faster and that energy demand needs to be reduced earlier, implying a higher cost than the 2 °C scenarios. However, he added that due to the limited model studies available, the cost results lack robustness and are uncertain. Another expert added that mitigation costs for 1.5 °C scenarios increase substantially not only in the long term, but in particular also in the short term.

---

[28] See AR5 WGIII, table 6.3, available at <http://www.ipcc.ch/report/ar5/wg3>.

152. Another Party asked experts to **comment on how mitigation fundamentally reduces the risk of warming and climate impacts, as well as on the cost of avoided impacts.** An expert said that the mitigation costs presented in AR5 WGIII for various temperature increases are not based on a comprehensive cost–benefit analysis, which was not carried out by WGIII and would require value judgments on uncertain avoided impacts, including impacts of a "catastrophic" nature (i.e. very large impacts with a low probability). The Party further asked how to reconcile the fact that a delay in mitigation action would increase mitigation costs, and the fact that a 1.5 °C pathway would be more expensive than a 2 °C pathway. The expert drew a distinction between mitigation costs and the notion of net benefits. The 1.5 °C limit has a higher mitigation cost than a 2 °C limit, a difference which needs to be compared with avoided damages, which is the realm of WGII. He added that the costs information provided has no implications on whether or not it is worthwhile to pursue the 1.5 °C limit (see paras. 155 and 157 below).

153. In a follow-up comment on the fact that the rapid increase in mitigation costs of reaching the 1.5 °C limit may not be matched by the reduced impacts, the Party pointed out that four out of the five RFCs show that the impacts of climate change increase in a non-linear fashion between 1.5 °C and 2 °C, especially for unique and threatened systems (e.g. the massive loss of coral reefs), large-scale singular events (e.g. the disintegration of ice sheets in Greenland and Antarctica in this warming range), or impacts on local agriculture. The Party asked about the comparison between the increased costs of mitigation, the reduced costs of adaptation and the avoided non-monetary impacts between these two limits.

154. A Party commented on the usefulness of the graphic presented in figure 41 and asked if this could be generated for a 1.5 °C limit for global warming. An expert stated that a publicly available IPCC database can be used to generate such graphics for 1.5 °C, 3 °C and 4 °C limits of global warming.

155. Responding to a question regarding **the current atmospheric concentration of CO_2 eq**, an expert indicated that in 2011 the concentration was about 430 ppm CO_2 eq, noting that current concentration levels are within the lower range of the 430–480 ppm category and that it has already become evident that achieving such concentration levels in 2100 without temporary concentration overshoot will therefore be very difficult.

156. In response to a question on the **role of non-CO_2 GHGs** in achieving low-emission scenarios and possible policy implications (figure 42), an expert explained that the WGIII experts did not have the data to break down the emissions by gas at the sectoral level. He added that non-CO_2 GHGs such as methane (CH_4), nitrous oxide (N_2O) and some fluorinated gases, are dominated by agricultural sources since incentives exist in the energy sector to address CH_4 leakages. Furthermore, a switch to a less meat-rich diet and a reduction in red meat consumption would yield further CH_4 emission reductions. However, not all models are responsive to such a change in consumption patterns and many uncertainties exist in the AFOLU sector in relation to demand-side measures. Another expert added that this matter was addressed in the industrial sector. On a follow-up question related to the role of **short-lived climate pollutants** and on policies to reduce them, an expert underlined that in many cases they are co-emitted with GHGs. While recognizing that the reduction of those short-lived forcers that have warming effects is beneficial, he warned that such policies focusing on short-lived gases should not be seen as a substitute for reducing other GHGs, in particular long-lived CO_2.

157. Regarding **assumptions related to bioenergy and** CCS uptake in terms of achieving negative emissions in the second half of the twenty-first century, an expert clarified that some coordinated studies with harmonized assumptions have been carried out and are reflected in the cost estimates presented (table SPM.2). However, he emphasized that, in general, the assumptions vary greatly depending on the studies and models used to make the assessment.

158. Noting that the **costs of emissions reduction in 2050** were presented in table SPM.1 for a wide range of reductions (e.g. a 41–72 per cent emissions reduction in 2050 for scenarios likely to stay under a 2 °C limit), a Party asked if details of mitigation costs could be provided, such as costs for specific levels of emissions reduction in 2050 and marginal costs. An expert underscored that the levels of emissions reduction in 2100 are dramatically different across categories; mitigation action in 2050 is key, where emission reduction levels are different between categories; and chapter 6 of AR5 WGIII contains additional information on marginal mitigation costs. **For 1.5 °C warming scenarios, the required mitigation action in 2030 is very different from the action required for 2 °C warming scenarios.** He underlined that the cost-effectiveness of mitigation action is shown by all models and relates to the monetization of co-benefits. Another expert pointed to the difficulty of monetizing the social costs of carbon, in particular taking into account impacts, using discount rates

and considering low-probability high-impact events, which explains why WGIII confined its assessment to mitigation costs (see paras. 151 and 152 above). With regard to co-benefits, he added that it would be incorrect to directly combine the mitigation costs assessed by AR5 WGIII with the co-benefits reported in other sources of information because an evaluation of co-benefits would require an evaluation of the difference between the current level of regulation and an optimal level of regulation, for example for sulphur dioxide or black carbon. A third expert stressed the low reliability of estimated damage costs included in integrated assessment models,[29] noting that they should only be used with caution. In addition to the challenges of monetizing social costs or the choice of a discount rate, he pointed to an institutional issue, namely the gap between WGII, which studies impacts with a small number of economists, and WGIII, which has more economists but less information on impacts and on the calculation of damages.

159. A Party asked about the **differences in mitigation costs among regions and countries**. An expert said that these differences relate to burden-sharing and that in integrated systems, emission reductions to achieve a global target occur where it is cheaper to do so, without necessarily implying that the reductions are paid for by the country where they occur. Reductions could occur under an effort-sharing scheme, with carbon allowances and trade flows, as in the example presented in figure 6.30 of AR5 WGIII.

160. Regarding the **Cancun pledges**, a Party asked whether the uncertainty related to the projections beyond 2020 or to the translation of the pledges in a quantifiable emissions reduction. An expert explained that the main driver of differentials is the fact that the pledges are frequently not clearly formulated, pointing to the upper and lower values of the pledges that depend on policy decisions. Another Party asked for the experts' views on what could be done to bridge the gap between the Cancun pledges and what is required to maintain a temperature increase below 2 °C.

161. As to the **effectiveness of the Kyoto Protocol**, one Party disagreed with the expert presentation and noted that the Kyoto Protocol is the only existing rule-based instrument. He added that CDM projects have resulted in real climate change mitigation benefits, based on the robust certified emission reduction system that has mobilized over USD 215 billion of investments in developing countries as of June 2012, with USD 5–13 billion of direct benefits to developing countries, and which has resulted in over 1.5 billion tonnes of avoided CO_2.[30] Noting that it often takes time for policies to bear fruit, another Party asked about the expected results of policies in the years to come. The expert indicated that there is agreement regarding the good performance of carbon taxes over the past 20 years and the mixed experience with emissions trading over the past 10 years. Regarding market-based mechanisms, including the CDM, he recognized that a large number of projects have been generated, but clarified that what is debated by experts is whether the mechanisms always fulfil the environmental integrity target. He added that the market-based mechanisms under the Kyoto Protocol are fast in learning the experience and that the effectiveness of policies is likely to increase in the long term.

162. In response to a question on the **relationship between carbon taxes and technology policies** and on national and regional action to enhance the **effectiveness of technology policies**, an expert answered that the introduction of pricing provides incentives for technology development, pointing to some successful examples of carbon taxing and emissions trading. He added that the determination of the effectiveness of various policies aimed at the selection of a particular technology was still unclear. The Party further asked about the coverage of emissions by national climate policies. The expert said that large countries in Asia and Latin America adopted national climate polices with increased emissions coverage between 2007 and 2011, but the type and effect of these polices had not yet been assessed.

163. Regarding the **reduction of emissions in the forestry and other land use** sectors, a Party commented that although it strives to reduce its deforestation rates, these efforts "mean nothing" unless they are accompanied by emission reductions from fossil fuels and cement production, which were in the order of 10 GtC

---

[29] See AR5 WGIII, chapter 3, available at <http://www.ipcc.ch/report/ar5/wg3>.

[30] See *Benefits of the Clean Development Mechanism 2012*, annex B, available at <http://cdm.unfccc.int/about/dev_ben/ABC_2012.pdf>.

per year in 2010 compared with 1 GtC per year for land use,[31] as well as by the development of CCS technologies.

164. In relation to hydropower, one Party asked for clarification regarding the high emissions from electricity supply sources and the related uncertainties for hydropower emissions. Another Party asked whether the uncertainties relate to hydropower itself or to the difference between the hydropower station, such as its location, and how it is developed. An expert answered that uncertainties stem from the availability of water; competition with forest conservation; and uncertainties of policies on decentralized hydropower stations. Another expert added that location drives a range of uncertainties; for example, in tropical areas when a dam is constructed, strong CH_4 emission peaks occur in the first 10 years following the associated decomposition of biomass.

165. Several Parties asked for clarification of **public and private climate finance flows**, noting that the figures presented showed that about 10 per cent of total climate finance comes from public sources. An expert explained the debate is still continuing as to whether or not climate finance is more than just the incremental finance that drives high-carbon investments to low-carbon investments. The figure of USD 350 billion relates to the entire amount of investment, of which only a small proportion may be driven by climate change related flows, which may explain why the actual amount of public finance is much lower than the entire amount of investment. He added that the low evidence level of this finding is related to the lack of definition of what constitutes climate finance, calling for guidance at the political level on this matter. Another Party asked about the definition of public climate finance, and whether the USD 35–49 billion figure for public finance relates to total public finance or only the finance flowing to developing countries. The expert clarified that the public climate finance figures are from the fast-start period (public finance flows to developing countries).

166. One Party asked about the **timeline for achieving tariff parity in the power generation sector**, in particular among fossil fuels with CCS, renewables and nuclear energy, which would allow a seamless transition from one energy source to another. An expert pointed to the difficulties of responding to a question relating to grid parity and levelized cost of electricity, underlining that levelized cost of electricity is not a very useful indicator for identifying the optimum timing for different technologies and combining intermittent (e.g. renewables) and base-load technologies. Grid parity would require consideration of the different possible pathways to decarbonize the power sector; for example, with more renewables or with more CCS and nuclear energy. The full range of scenarios must therefore be studied, as well as the system costs of electricity, rather than the technology level.

167. Responding to a question on whether **literature published after the IPCC's cut-off date** could alter the findings of AR5 WGIII, an expert said that the additional literature would require a new assessment, noting that on the subject of bioenergy alone, roughly 5,000 peer-reviewed publications have been released over the past three years. He added that, to the best of his knowledge, there are no new findings that would fundamentally change the AR5.

F. Part 4 – theme 2: overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention based on the contribution of Working Group III to the Fifth Assessment Report

1. Presentations by experts

168. Mr. Gabriel Blanco (IPCC) made a presentation on trends in stocks and flows of GHGs and their drivers, explaining that the years 1970–2010 were used as a reference period, being the smallest common denominator for all gases. He added that for CO_2 emissions, some data are available until 2012, and long-term historic data are available for the period 1750–2010. Short-lived climate forcers were not included in the historic assessments due to their limited residence in the atmosphere.

169. WGIII analysed GHG stocks and flows from multiple perspectives: cumulative CO_2 emissions; GHG emissions per region, gas, sector, capita and GDP; production-based GHG emissions; and consumption-based

---

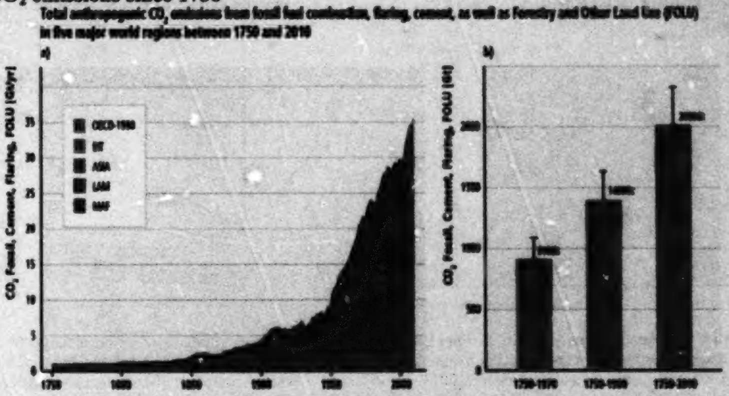
[31] See figure TS.4 in the technical summary in the contribution of WGI to the AR5, available at <http://www.ipcc.ch/report/ar5/wg1>.

GHG emissions. **Cumulative CO_2 emissions have more than doubled over the last 40 years compared to pre-industrial levels**, and annual anthropogenic GHG emissions have increased by 2.2 per cent per year over the past decade, despite reduction efforts, with CO_2 remaining the main contributing gas to these emissions (65 per cent from fossil fuels and industrial processes). Energy-related emissions increased by 36 per cent in the last decade, followed by industry (a 45 per cent increase) and transport (an 18 per cent increase). The fact that the five databases used by WGIII contain very similar data illustrates the robustness of the data sets when harmonized to cover the same sources (figure 50).

170. The comparison of **GHGs per capita and GDP per capita** shows a marked upward trend for Asia (GHG per capita grew with the increase in GDP per capita), while the trend is linear for member countries of the Organisation for Economic Co-operation and Development (OECD) (figure 51). OECD countries have larger **consumption-related emissions than production-related emissions**, while the reverse is true for the Asia region (figure 52). This is because a growing share of CO_2 emissions from fossil-fuel combustion and industrial processes in low- and middle-income countries has been released in the production of goods and services exported to high-income countries.

Figure 50

Cumulative CO_2 emissions since 1750



Source: Slide 4 of the presentation by Mr. Gabriel Blanco (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_wgiii_ar5_blanco_final.pdf>.The figure shows CO_2 emission levels for the 1750–2010 reference period.

Abbreviations: OECD-1990 = countries members of the Organisation for Economic Co-operation and Development in 1990; EIT = economies in transition; LAM = Latin America and the Caribbean; MAF = Africa and the Middle East.

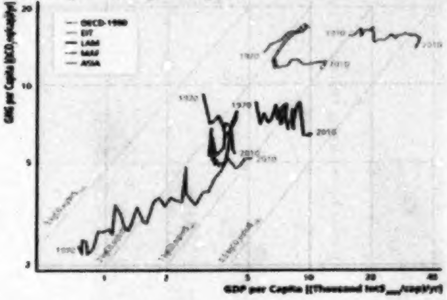
171. As regards **drivers of emissions**, Mr. Blanco drew a distinction between **immediate and underlying drivers**. The effect of **immediate drivers** of GHG emissions can be quantified, while the effects of underlying ones are more difficult to assess. Immediate drivers, or factors in the decomposition of total GHG emissions, include GDP per capita, which is the main driver of emissions, and population growth (figure 34). In the last decade, energy intensity has changed from reducing emissions to positively contributing to them, owing to a return to coal use in some countries since 2000 (figure 33). AFOLU is the only sector where the correlation between emissions and GDP growth is loose. **Underlying drivers, which are subject to policies and measures**, include fossil-fuel endowment and availability, consumption patterns, structural and technological changes, and behavioural choices.

172. Mr. Blanco underlined that both **economic and population growth have outpaced emission reductions from technological improvements in energy intensity**. Without additional efforts to reduce GHG emissions beyond those currently in place, emissions growth is expected to persist, driven by growth in global population and economic activities. Baseline scenarios result in global mean surface temperature increases in 2100 of between 3.7 °C and 4.8 °C (median values) compared to pre-industrial levels. He concluded by underscoring the need to examine the drivers of emissions when designing climate change strategies, and "looking at the past when planning for the future".

173. Mr. Sivan Kartha (IPCC) addressed the guiding question of SED 3, "How can current and future efforts to implement commitments under the Convention increase mitigation ambition and keep us on track for keeping global warming below 2° C/1.5 °C", and focused on the equity and ethical concepts relevant to international cooperation toward the long-term global goal (see para. 181(f) below). He presented three lines of argument relating to equity and equitable effort-sharing in relation to achieving the long-term global goal. The first is the **legal argument**, according to which Parties have accepted legal commitments to act against climate change in an equitable manner, with specific reference to equity in the Convention (Article 3, paragraph 1). The second is the **moral argument**, according to which it is morally proper to allocate burdens associated with the common global climate challenge according to ethical principles, which is a translation to the international level of the principles that are already generally respected at national level. The third is the **effectiveness argument**, that equitable effort-sharing will be necessary if the climate challenge is to be effectively met. This argument is based on the recognition that climate change is a global common problem. That is, effective mitigation will not be achieved if individual agents advance their own interests independently. Mr. Kartha said that this third argument is the strongest in the context of a global effort to cooperate on climate change.

Figure 51

Greenhouse gas emissions per capita versus gross domestic product per capita

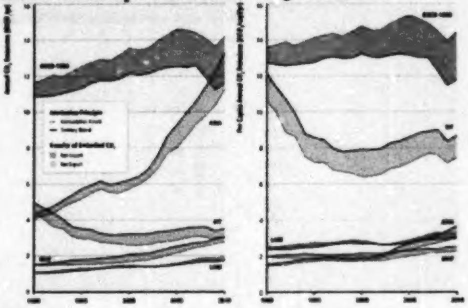


Source: Slide 9 of the presentation by Mr. Gabriel Blanco (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_wgiii_ar5_blanco_final.pdf>. The figure illustrates some of the relationships between greenhouse gas emissions per capita as a function of gross domestic product.

Abbreviations: OECD-1990 = countries members of the Organisation for Economic Co-operation and Development in 1990; EIT = economies in transition; LAM = Latin America and the Caribbean; MAF = Africa and the Middle East.

Figure 52

Production-related CO_2 emissions (territorial) versus consumption-related CO_2 emissions



Source: Slide 11 of the presentation by Mr. Gabriel Blanco (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_wgiii_ar5_blanco_final.pdf>. The figure illustrates the differences in production-related (territorial) and consumption-related CO_2 emissions.

174. Expanding on the **effectiveness argument and international cooperation**, he pointed out that no single country can protect its own climate by reducing its own emissions, and thereby no country can solve its climate change problem by itself. He underlined that countries thus undertake mitigation activities and cooperate in other ways, for example through financial and technological support, not only to directly protect their own climate, but also for the sake of inducing reciprocal effort in other countries. A country is more likely to be successful in seeking cooperation with other countries if perceived as doing its fair share of the effort. In short, a cooperative agreement based on effort-sharing that is seen to be equitable, and based on ethical principles may lead to more effective cooperation.

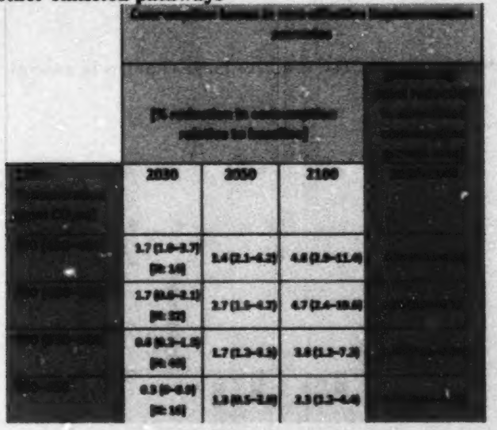
175. **Linking the arguments presented above with the costs of achieving the long-term global goal**, Mr. Kartha stressed that more than 100 scenarios assessed by the IPCC provide pathways for keeping global warming below the 2 °C limit (figure 35), at an estimated cost of a 1.0 to 3.7 per cent reduction in consumption relative to the baseline for 2030, or a growth reduction of 0.06 per cent per year, equivalent to around USD 1–3 trillion per year in 2030 (figure 53). He emphasized that these costs of roughly 1 to 4 per cent need to be

calibrated against a baseline growth of 300 to 900 per cent over the same period.[32] He noted that these scenarios imply stringent emission reductions starting in 2020, with global and regional emissions peaking in the next 10–15 years, which will require broad low-GHG transformation in all regions.

176. The **regional breakdown of mitigation expenditure**, based on mitigation potential (i.e. where each region undertakes mitigation up to a common equal marginal abatement cost), is as follows: the lowest expenditure is for OECD countries; it is twice that amount for Latin America; three times that amount for Asia; and four to five times that amount for Africa and the Middle East and countries with economies in transition (figure 53).[33] These figures reflect a distribution of costs that is the reverse of what might be expected if the mitigation burden was instead shared according to equity, which is at the core of the effort-sharing problem. Effort-sharing schemes have the potential to yield more equitable cost distribution across countries based on ethical principles rather than on mitigation potential. Effort-sharing approaches differentiate the mitigation costs borne in a region according to who pays for those costs, and thereby could provide a basis for compensatory payments across regions that can make climate coalitions effective and stable. There is a small set of widely invoked and rarely disputed ethical principles – founded on responsibility, capacity and equality – that forms the basis of discussions of frameworks for effort-sharing.

Figure 53

Estimated mitigation costs of a likely 2 °C limit and other emission pathways

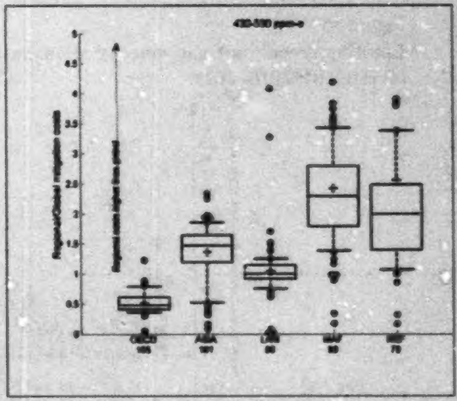


[illegible]	2030	2050	2100	[illegible]
[illegible]	1.7 (1.0–3.7) [N: 14]	3.4 (2.1–6.2)	4.8 (2.9–11.4)	[illegible]
[illegible]	1.7 (0.6–2.1) [N: 32]	2.7 (1.5–4.2)	4.7 (2.4–10.6)	[illegible]
[illegible]	0.6 (0.2–1.3) [N: 46]	1.7 (1.2–3.3)	3.8 (1.2–7.3)	[illegible]
[illegible]	0.3 (0–0.9) [N: 16]	1.3 (0.5–2.0)	2.3 (1.2–4.4)	[illegible]

Source: Slide 9 of the presentation by Mr. Sivan Kartha (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2-wgiii_ar5_kartha.pdf>. The figure shows the costs of mitigation.

Figure 54

Global distribution of mitigation expenditures, as a percentage of gross domestic product



Source: Slide 13 of the presentation by Mr. Sivan Kartha (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2-wgiii_ar5_kartha.pdf>.

Abbreviations: OECD-1990 = countries members of the Organisation for Economic Co-operation and Development in 1990; LAM = Latin America and the Caribbean; MAF = Africa and the Middle East; REF = reference across scenarios.

177. As to the broader **implications of mitigation measures for sustainable development** (see para. 181(g) below), Mr. Kartha explained that for each sector, WGIII looked at the interaction of climate policies with other societal objectives, although some uncertainties remain in identifying co-benefits or adverse side effects[34] and only a partial answer can be provided to this question. He noted that there are broad interactions between mitigation and all three pillars of sustainable development (i.e. the social, environmental and economic pillars), which results from the fact that the low-carbon transition being invoked is an encompassing transition of entire

---

[32] This overall reduction amounts to 0.1 per cent in the most optimistic assumption to 1.2 per cent in the most pessimistic assumption combination.

[33] See AR5 WGIII, figure 6.27, available at <http://www.ipcc.ch/report/ar5/wg3>.

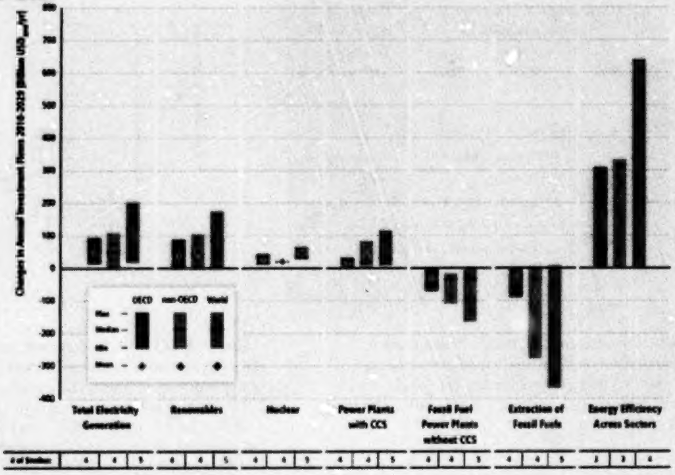
[34] See AR5 WGIII, table TS.3, available at <http://www.ipcc.ch/report/ar5/wg3>.

economic systems. Although co-benefits or adverse side effects can be substantial, they are often difficult to quantify (e.g., in monetary terms), and have not yet been thoroughly analysed. There is no "silver bullet" for enhancing co-benefits and reducing adverse side effects as they depend on local circumstances, as well as on implementation practice, pace and scale. However, practices that improve policies generally, such as good governance, transparency, stakeholder participation, cross-sectoral analysis and design, etc., are expected to help enhance co-benefits and reduce side effects. Nonetheless, these co-benefits are significant both in welfare and political terms, and managing the interactions between mitigation action and other societal goals implies mainstreaming mitigation into the broader context of sustainable development.

178. Mr. Luis Gómez-Echeverri (IPCC) made a presentation on **cross-cutting investment and finance issues** with a view to assessing the progress made towards achieving the long-term global goal. He underlined that this is the first time that an IPCC assessment report has included a chapter dedicated to climate finance and investments. He noted that there is **no** widely accepted **definition** of what constitutes **climate finance and climate investments;** scientific literature on investment and finance to address climate change is still very limited, and knowledge gaps are substantial. He presented an overview of climate finance, from possible sources of capital, managers of capital and financial instruments to adaptation and mitigation projects, and indicated that climate finance is estimated at USD 343–385 billion per year, with 95 per cent being allocated to mitigation action. Regarding the share of public versus private climate finance, flows to developing countries from public climate finance amount to USD 35–49 billion per year, and flows from private climate finance amount to USD 10–72 billion per year.

Figure 55

Limiting greenhouse gas concentrations to 430–530 ppm by 2100 requires large changes in annual investment: 2010–2029



Source: Slide 7 of the presentation by Mr. Gómez-Echeverri (Intergovernmental Panel on Climate Change), available at <https://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_gomez_sed3.pdf>. The figure shows the required investment change by sector for a possibility of limiting global warming to 2 °C.

Abbreviations: CCS = carbon capture and storage; OECD = countries members of the Organisation for Economic Co-operation and Development.

179. Mr. Gómez-Echeverri underlined that: resources to address climate change need to be scaled up considerably over the next few decades, both in developed and developing countries; public revenues can be raised by collecting carbon taxes and auctioning carbon allowances; and emission scenarios that limit temperature increase from pre-industrial levels to below 2 °C require considerably different investment patterns during the period 2010–2029, including a fall in investments in fossil-fuel plants without CCS of USD 30 billion, an increase by USD 147 billion in investment in low-emission generation technologies, and an increase by USD 336 billion in energy-efficiency investments in the buildings, transport and industry sectors (figure 55).

180. He emphasized that **increasing access to modern energy services** to meet basic cooking and lighting needs could yield substantial improvements in human welfare at relatively low cost and with only minor effects on global GHG emission levels (USD 72–95 billion per year until 2030 to achieve nearly universal access).

181. Essential elements to scale up climate finance include: the existence of enabling environments that would allow private-sector investments to be scaled up; the de-risking of climate investment; appropriate governance and institutions at all levels; and synergies and trade-offs between mitigation and adaptation financing.

2. General discussion

182. The ensuing discussion was guided by the following questions:

(a) What are the global trends in historical, current and future GHG emissions and ambient GHG concentrations, including mitigation pathways for meeting the long-term global goal? What is the degree of probability?

(b) What are the key drivers of trends and projections of global GHG emissions and subsequent radiative forcing by sector, region and gas?

(c) Which policies and measures that appear to be reducing emissions, or that show emission reduction potential, could be strengthened, or emulated?

(d) How can long-term policy effects, such as investments in technological innovation, be evaluated? How could this possibly be factored into policymaking under the Convention?

(e) What are the assumptions for policies in the 'business as usual' scenario and what is their aggregate mitigation potential and uncertainty? Is there any gap between the actual mitigation and that needed to reach the long-term global goal and, if so, how could it be bridged? How could the implementation of these efforts be further assessed?

(f) How can current and future efforts to implement commitments under the Convention increase mitigation ambition and keep us on track to limiting global warming below 2 °C or 1.5 °C?

(g) What are the social and economic impacts of the implementation of mitigation measures on developing countries within mitigation pathways for various levels of global mean warming? What is the relationship between mitigation and impacts in terms of key risks, notably for the most vulnerable people and systems as assessed by AR5 WGII?

183. With regard to the **costs of mitigation in Africa**, the assumptions used and the question whether adaptation and disaster risk reduction were considered, an expert clarified that Africa would have the highest mitigation costs because costs have been calculated as a percentage of GDP and its GDP is low; estimates take into account not only present emission levels, but also their projected growth; and the region for which results are presented includes Africa and the Middle East. The cost figures presented are for mitigation only. In response to a follow-up question by a Party on the impacts of technological leapfrogging on the costs of mitigation in different regions, the expert stated that the acceleration of leapfrogging through, for example, a technology mechanism, would indeed reduce mitigation costs, but since historically this has only happened in few cases, there is an assumption of minimal leapfrogging built into the assessment based on models calibrated with historical data. Another expert added that middle- to high-income countries tend to replicate the historical development of high-income countries. Hence, current evidence shows that leapfrogging is limited (figure 33). Leapfrogging could be accelerated in the future, but only if there is a reliable carbon-pricing signal. In response to a question related to the identification of 'low-hanging fruits' in terms of global mitigation actions, an expert confirmed that there are indeed some indications of 'negative mitigation costs' for the building sector. He added that there are many options to decarbonize the power sector; transport will be the most challenging sector to decarbonize (few options); and carbon pricing allows finding for the detection of a way across all sectors of the economy to identify 'low-hanging fruits', taking into account the timing of mitigation action that is otherwise difficult to address. In response to a comment by a representative of civil society who pointed to some cost-effective options for the transport sector, the expert stated that achieving the low-emission scenarios in the second half of the twenty-first century requires negative emissions and therefore also depends on options to decarbonize the transport sector, irrespective of whether or not cheap electric vehicles are available.

184. Regarding **climate finance**, a Party expressed its surprise at the high **percentage of climate flows directed towards mitigation** (95 per cent) and asked if this could be related to a problem with the definition of "adaptation finance". An expert explained that the figure is in part due to the definition of adaptation finance, which is often difficult to distinguish from development or disaster risk management flows. He added that private-sector finance, which constitutes the largest part of climate finance, is definitely mostly channelled to mitigation. Responding to another question about the assumptions used in the projections of required climate finance, the expert explained that the assessment indicates that a major transformation is required to achieve the scaling-up of investment. He emphasized that elements of the enabling environment to achieve this transformation, in particular when targeted at the private sector, include greater certainty in policies, policies to lower the costs of capital, and the de-risking of investments, including a consistent carbon pricing.

185. A Party suggested **assessing progress towards the long-term global goal by breaking it down to a partial temperature limit for each decade** (e.g. 0.1 °C), based on best available science and updating it based on reduction of uncertainties and action on mitigation. An expert pointed to various difficulties of doing so, namely that: in addition to a limit in the change in global mean temperature as a long-term global goal at the end of the twenty-first century, it should be associated with a 'speed limit' at which temperature changes, which can only be assessed when the effect on impacts is also considered; the 2 °C and 1.5 °C targets can only be achieved with concentration and/or temperature overshoots; and any assessment of such an approach should therefore also be carried out in coordination with WGII. He added that the IPCC currently has no mandate to make the assessment suggested, as it would require a closer collaboration or even a merging of WGII and WGIII, but that such tasks could be part of the IPCC's future work.

186. Responding to a question on the **impact of fossil-fuel subsidy removal on emission reductions**, including on the refocusing of public expenditures, an expert explained that WGIII had not been able to carry out this quantification because of the absence of the required large-scale modelling comparison exercise. In response to a follow-up comment from a Party, he added that although no quantitative assessment has been carried out, chapter 16 of AR5 WGIII could only provide qualitative descriptions of the benefits of the removal of these subsidies. For example, reducing fossil-fuel subsidies would lower emissions and release public funds for other purposes. The expert also underlined the importance of the context in which such a removal is carried out, in particular the need for it to be accompanied by a pricing of carbon.

187. One Party noted that in the next 15 years, it will be necessary to transition from a 2.2 per cent per year increase in global emissions to an unprecedented reduction of 3 per cent per year, while the underlining drivers of emissions are increasing. The Party asked **where the focus of policymakers should lie in order to achieve the radical transformation called for in AR5 WGIII to achieve the long-term global goal**, and if such a transformation is feasible. An expert replied that all scenarios illustrate that the carbon price is a necessary condition, which should be complemented by additional policy instruments aimed, for example, at curbing carbon leakage effects and integrating all sectors, including land use. He added that significant additional research is required to design such policymaking packages. He commented that the price of carbon needs to be increased over time and that all sectors should be subject to this pricing, warning against the risk of carbon leakage if some sectors are exempt from the pricing. Responding to a follow-up question, he stressed the importance of having comprehensive carbon pricing that is not merely based on the fossil-fuel sector. To be successful, such a carbon-pricing scheme requires not only the inclusion of the land-use sector but may also call for a fundamental change in that sector. Another expert emphasized the feasibility as well as the significance of consumption patterns and behavioural changes, and underscored the importance of the Paris agreement.

188. An expert highlighted that AR5 WGIII indicates that **the required transformation is technologically feasible**; the **costs are manageable**, especially in the light of the stakes at hand; and various **policy portfolios could be deployed**. The key question is the political feasibility of the transformation, since WGIII calls for a fundamental transition that implies a "serious political challenge" with winners and losers. He added that the difficulties involved with such a near-term transition have not been assessed. Another expert pointed to the strong role of institutions in order to assess the feasibility of the required transition, calling for the capacity-building of decision makers in developing countries to enable them to make the right decisions. Responding to a follow-up question from a Party on the definition of these enabling environments, another expert noted the need to look at success stories, not least from a country-specific perspective.

189. Commenting on the **importance of pricing carbon**, a Party pointed to the uncertainties of technological developments, noting that a major technological breakthrough could generate significant mitigation benefits at

low cost and that most of the scenarios analysed do not decouple economic growth and emissions growth. An expert explained that such a technological development cannot be anticipated, but that AR5 WGIII indicates that the lowest emission scenarios can be achieved through the scaling-up of existing technologies. Any technological breakthrough would additionally improve the situation. He added that without a carbon price, technological advances will not solve the climate challenge because of the risk of a very high rebound effect. Regarding decoupling economic growth and emissions growth, an expert said both high- and low-growth pathways are possible, with the latter making it easier to achieve such decoupling. Another expert stressed that the assessment of policies shows that those that have had a consistent carbon price over a long period have been effective, whereas those that did not include such a pricing were not necessarily effective. In response to a follow-up question regarding the long-term benefits of mitigation polices, he mentioned the example of the successful use of carbon taxing in Scandinavian countries for 20 years, emphasizing that there is a sufficient body of evidence on mitigation policies that will deliver results if applied consistently. Another Party pointed to its experience with such carbon taxes and its associated quota system, underlining that to achieve a technological change, the carbon pricing should be supplemented by other policy instruments. He drew attention to chapter 6 of AR5 WGIII on transformation pathways, which can help to **determine how high the price of carbon should be set to achieve the 2 °C goal.**

190. In response to a question on the **uncertainties in the estimates of different gases**, an expert explained that uncertainties exist in all databases used in the assessment, for all gases and sectors (in the full report). However, he noted that despite the uncertainties, the upward emissions trend is clear. On a follow-up question regarding the **uncertainties related to the assumptions for 'business as usual' scenarios**, an expert explained that a large-scale modelling comparison exercise was carried out for **'business as usual'** scenarios and the uncertainties related to the assumptions were reduced. However, there are significant differences in the assumptions used for technologies, learning curves and externalities for mitigation scenarios within each model. With the establishment of the modelling community, these assumptions could be better estimated and uncertainties further reduced in the future.

191. In response to a question related to the **definition of and assumptions behind 'business as usual' scenarios**, in particular inasmuch as these relate to RCP scenarios also used by WGI, an expert explained that **WGIII 'business as usual' scenarios are typically consistent with RCP8.5, but cover a much broader range of possible future scenarios**. He added that the 'business as usual' scenarios include known polices, such as the Cancun pledges.

192. Commenting on the data on **consumption- and production-based emissions**, a Party asked for suggestions as to how to achieve substantial emission reductions in the context of globalization. Another Party noted that while the production-based emissions of OECD countries have decreased, their consumption-based emissions increased, emphasizing the need for a global perspective to effectively mitigate climate change. An expert stated that an analysis of this matter was carried out based on the available literature rather than by using data from databases. He said that there is no clear answer, underlining the need to look at all sources of emissions and their drivers, including consumption patterns and behavioural changes. Another expert added that production- and consumption-based accounting should not be used to identify responsibilities nor misused to imply particular emission reduction measures, stressing that in studies assuming an ideal world, the method used to account for emissions is irrelevant.

G. Reflections on the third meeting of the structured expert dialogue

193. SED 3 was well attended, bringing together many government delegates and experts from all regions, as well as civil society representatives. During each of the four parts of the meeting, the time dedicated to discussions was substantial and balanced between the two themes of the 2013–2015 review. Parties actively engaged in a rich exchange of views with experts that enabled an in-depth discussion of the findings of AR5 WGII and AR5 WGIII as they pertain to the 2013–2015 review. SED 3 saw Parties and IPCC experts engage in a remarkably constructive, productive and rich manner in all discussions. Consequently, the dialogue was deepened, with many follow-up questions and comments. We believe the productive and informative discussions at SED 3 supported Parties in internalizing the key findings contained in AR5 WGII and AR5 WGIII, which are relevant to both themes of the 2013–2015 review, thus completing the consideration of the contributions of all three working groups to the AR5.

194. At SED 2, a number of issues were identified as requiring further consideration at SED 3, namely: risk management, including the relationship between risk and overshooting of the long-term global goal, the geographical distribution of risks given regional differences in impacts and in economic or other costs of adaptation for various levels of warming; and the underlying assumptions, feasibility and cost of impacts, mitigation and adaptation in terms of RCPs and other scenarios considered by the IPCC, as well as the temporal aspects of emission pathways while considering aspects such as short-lived GHGs and commitments in carbon infrastructure. At SED 3, these issues were fully addressed by the IPCC experts in their presentations and during the discussions with Parties.

195. Nonetheless, the discussions at SED 3 underlined a number of issues where additional information and discussions would be required at future meetings of the SED, including: the evaluation of the costs of adaptation; the assessment of the value of the co-benefits of climate change mitigation; and the assessment of the 1.5 °C temperature limit. However, the IPCC repeatedly emphasized that their hands are tied, pointing out that scientific insights on the 1.5 °C limit are limited since results of the needed research are not yet available or not of the same robust nature as those on the 2 °C long-term global goal.

196. At SED 3, IPCC experts stated repeatedly that assessing the adequacy of the upper limit for global warming in the light of Article 2 of the Convention involves both risk assessments and value judgments. In the AR5 the IPCC assessed risks across contexts and through time, providing an analytical framework that can be a foundation for a collective agreement on how much global warming is acceptable. While recognizing that the work of the SED is still ongoing, it is already a successful vehicle for informing and supporting policy formulation, taking into account the various values and recognizing that what constitutes an intolerable risk may differ across sectors, regions and countries.

197. One of the clear messages that emerged from SED 2 and SED 3 is that limiting global warming to below 2 °C calls for adopting a long-term approach to climate change, which in turn calls for science-based management of the global pathway towards a low-carbon and climate-resilient future. To that end, the SED has been able to contribute considerably to an increased understanding of the relationship between near- and long-term actions on mitigation and adaptation. Furthermore, the periodic review of the long-term global goal can play a positive and essential role in any process established for assessing the progress made towards achieving the long-term global goal, thereby strengthening the science–policy interface.

198. We, the co-facilitators, believe that the approach taken at SED 3 worked well and we congratulate Parties and experts for a successful meeting, while encouraging all stakeholders to maintain this positive and collaborative spirit at future meetings of the SED.

Annex IV

Summary report on the fourth session of the structured expert dialogue

I. Introduction

A. Mandate

1. At their thirty-ninth sessions, the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI) requested us, the co-facilitators of the structured expert dialogue (SED), to organize SED meetings in 2014 in conjunction with the fortieth and forty-first sessions of the subsidiary bodies.[1]

2. In response to the above-mentioned mandate, we convened the 1st meeting of the fourth session of the SED (SED 4-1), on 2 and 3 December 2014, in Lima, Peru, during SBSTA 41 and SBI 41 to consider the Synthesis Report (SYR) of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5),[2] as well as other information from the sources referred to in decision 2/CP.17, paragraph 161 (b–d).[3] Prior to SED 4-1, we provided Parties with an information note outlining our approach to the organization of the meeting.[4]

3. SBSTA 40 and SBI 40 requested the co-facilitators of the SED to convene an additional meeting of the SED after SBSTA 41 and SBI 41, in conjunction with a meeting of the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) and prior to SBSTA 42 and SBI 42, to consider further inputs referred to in decision 2/CP.17, paragraph 161, in particular its subparagraphs (b–d), with a view to closing the SED prior to SBSTA 42 and SBI 42 in accordance with decision 1/CP.18, paragraph 91.[5] As indicated at SBSTA 41 and SBI 41,[6] the 2nd meeting of the fourth session of the SED (SED 4-2) was held on 8 and 9 February 2015 in Geneva, Switzerland, in conjunction with the eighth part of the second session of the ADP. Prior to SED 4-2, we provided Parties with an information note outlining our approach to the organization of the meeting.[7]

B. General objective and approach of the meeting

4. SED 4-1 focused on the AR5 SYR, which distilled and integrated the key elements of the contributions of the three IPCC Working Groups to the AR5, as well as the two IPCC special reports produced during the fifth assessment cycle, which are relevant to both themes of the 2013–2015 review, and information sources other than those of the IPCC identified in decision 2/CP.17, paragraph 161(b–d), with a view to complementing, summarizing and conceptualizing the information already discussed at previous SED meetings. At its final meeting, the SED aimed to complete its work by addressing, in a balanced manner, all remaining inputs to the 2013–2015 review and information that has been published after the cut-off dates of the IPCC AR5, and by identifying information gaps.

5. Accordingly, we organized SED similarly to previous SED meetings as a fact-finding exchange of views between experts and Parties. Experts from the IPCC, processes under the Convention, United Nations agencies and other organizations presented findings from their reports, and highlighted their relevance to both themes of

---

[1] FCCC/SBSTA/2013/5, paragraph 133, and FCCC/SBI/2013/20, paragraph 167.

[2] Available at <http://unfccc.int/7521.php>.

[3] FCCC/SBSTA/2014/2, paragraph 74, and FCCC/SBI/2014/8, paragraph 193.

[4] Available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/sed4_informal_note_14_nov.pdf>.

[5] FCCC/SBSTA/2014/2, paragraph 75, and FCCC/SBI/2014/8, paragraph 194.

[6] FCCC/SBSTA/2014/5, paragraph 46, and FCCC/SBI/2014, paragraph 109.

[7] Available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/information_note_sed_4-2_final.pdf>.

the 2013–2015 review. In addition, regional research centres presented on observed impacts of climate change. These presentations were followed by a moderated discussion guided by questions prepared by the co-facilitators[8] based on questions provided by Parties through their submissions,[9] questions from participants and additional questions provided by some Parties before each part of the meetings.

II. Summary of the proceedings

6. SED 4 consisted of two meetings,[10] while the deliberations were organized in four parts and were open to all Parties and observers. Part 1 was held on 2 December 2014 (3–6 p.m.), part 2 was held on 3 December 2014 (3–6 p.m.), part 3 on 8 February 2015 (3–6 p.m.) and part 4 on 9 February 2015 (10 a.m.–1 p.m. and 3–4.30 p.m.). SED 4-1 comprised parts 1 and 2, and SED 4-2 comprised parts 3 and 4. The meetings were chaired and moderated by us, the co-facilitators.

7. **SED 4** was opened by Mr. Manuel Pulgar-Vidal, President of the Conference of the Parties (COP) at its twentieth session and the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) at its tenth session. Noting that the United Nations Climate Change Conference held in Lima is a **key time and place to reconcile science and policy**, he said the AR5 SYR has already highlighted some topics and outlined options that we should take into account in order to "move the decision making process towards success". While recognizing that the SED is still ongoing, he stated that it has already been effective in enabling a science-based management of the global pathway towards a climate-resilient future. Noting that this is the first time such a review has been carried out, he said that COP 21 is expected to take appropriate action on the basis of the outcomes of the 2013–2015 review and underlined that the meeting of the SED will be an essential part of this outcome as it aims to distill and conceptualize the available relevant information with a view to conclude the review. Mr. Pulgar-Vidal added that by the end of 2015 "we aim to have a solid and strong agreement". Noting that citizens are aware of the science that has been delivered to policy makers, he said it is now up to them to show they are acting on that basis.

8. Mr. Andreas Fischlin, a co-facilitator of the SED, outlined the structure of the meeting, noting that the discussion would focus on the two themes of the review: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention (theme 1), and overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention (theme 2), which will be addressed in a balanced manner. He explained that part 1 will focus on the AR5 SYR while part 2 will consider non-IPCC information sources. Although experts will make presentations on both themes, separate discussions will be held on each. Mr. Fischlin stressed the need to finish complementing and start conceptualizing the information considered by the SED in order to finish the dialogue soon. He encouraged IPCC experts to focus on information coming from the distillation of the contributions of the three Working Groups to the AR5 and the SYR, and invited Parties to make succinct interventions to allow for a fruitful dialogue.

9. **Part 1** of the meeting opened with an introductory presentation made by an IPCC expert on the overarching findings of the AR5 SYR that are relevant to both themes of the 2013–2015 review. Subsequently, two presentations focused on: the adequacy of the long-term global goal in terms of preventing unacceptable consequences for ecosystems and food production, and for sustainable economic development; and on the adequacy of the 2 °C upper limit of temperature rise in terms of risk management within planetary boundaries and progress towards the long-term global goal. The presentations were followed by a substantive discussion guided by questions.

10. **Part 2** of SED 4-1 focused on information from United Nations agencies and intergovernmental organizations relevant to the 2013–2015 review. A SED co-facilitator, Mr. Zou Ji, opened the meeting by explaining that presenters from United Nations organizations and intergovernmental organizations would address: the mitigation and adaptation gaps; food production and security; the health impacts of climate change and mitigation co-benefits; how to set the price of carbon; and the decarbonization of the energy system as well

---

[8] For the list of questions, please see the SED 3 agenda, available at <http://unfccc.int/7521.php>.

[9] The submissions from Parties are available at <http://unfccc.int/science/workstreams/the_2013-2015_review/items/7590.php>.

[10] See paragraphs 2 and 3 above.

as related technology perspectives. He added that presenters would also describe relevant activities by their organizations to support progress towards achieving the long-term global goal, as well as best practices and lessons learned in streamlining support that can lead to effective mitigation of, and adaptation to climate change. Mr. Zou Ji stressed that although presenters would address both of the two themes of the review, their presentations would be followed by separate discussions on themes 1 and 2.

11. Part 2 started with presentations on key findings of the United Nations Environment Programme (UNEP) *The Adaptation Gap Report 2014*[11] and *The Emissions Gap Report 2014*,[12] followed by a presentation by the Wold Bank, which focused on the need to reduce **net carbon dioxide (CO_2) emissions to zero**, elements common to all models that provide the emission reductions required to bring emissions to zero at the end of the century, the role of carbon pricing and climate change impacts in a world 4 °C warmer. The International Energy Agency (IEA) presentation focused on the challenges and opportunities related to energy and climate change, describing: the current state of the energy sector, modelling results and five key actions to achieve a low-carbon energy sector, and issues related to technology risk and risk management. The World Health Organization (WHO) presentation focused on the health impacts of climate change and the Food and Agriculture Organization of the United Nations (FAO) presentation focused on agriculture, food security and climate change. The presentations were followed by a substantive discussion guided by questions.

12. **SED 4-2** took place on 8–9 February 2015 in Geneva, Switzerland. The meeting consisted of two parts. On 8 February, part 3 of SED 4 focused on information from United Nations agencies, international organizations and processes under the Convention. On 9 February, part 4 considered regional and emerging information. Mr. Zou Ji welcomed delegates and opened the meeting.

13. In his opening remarks, Mr. Tomasz Chruszczow, the Chair of the SBSTA, addressed the relationship between the SED and the joint contact group on the 2013–2015 review, which was established by the SBSTA and SBI. He said that the report on SED 4 and the final factual report on the SED (to be prepared by the co-facilitators) will constitute key inputs to the work of the joint contact group when it meets during the forty-second sessions of the subsidiary bodies in June 2015 to formulate recommendations to the COP on the 2013–2015 review, including on a possible decision and appropriate action for consideration by the COP.

14. Mr. Chruszczow then outlined some key messages emerging from the meetings of the SED so far, focusing on theme 1 of the 2013-2015 review, the adequacy of the long-term global goal:

(a) The first message was on the nature of the 2 °C and 1.5 °C limits to global warming. He emphasized that at SED 2, SED 3 and SED 4-1, many experts, notably from the IPCC, had explained that climate-related impacts are prevalent at the current degree of warming of 0.85 °C above the pre-industrial level and have increasingly significant adverse effects, and that additional magnitudes of warming will only increase the risks of severe, pervasive and irreversible impacts. He stressed that this is an indication that any upper limit for global warming can no longer be seen as a guardrail providing protection from dangerous anthropogenic interference, and called for a consideration of societally, or otherwise, acceptable risks of climate impacts;

(b) The second message was related to the adequacy of the upper limit for global warming. Mr. Chruszczow noted that at SED 3, IPCC experts stated repeatedly that assessing this adequacy in the light of Article 2 of the Convention involves both risk assessments and value judgments, and indicated that climate change related risks from extreme events and risks to unique and threatened systems are high with additional warming of around 1 °C. He stated that this provides a solid analytical framework that can provide a foundation for a collective agreement on how much global warming is acceptable;

(c) The third message focused on the limitations related to working with a temperature limit only. He emphasized that at SED 2 and SED 3, experts had pointed to some of these limitations, in particular in relation to the global mean sea level rise or ocean acidification, but underscored that such limitations do not change the basic finding emerging from an assessment of the temperature limit, namely that we need to take urgent and strong action, on the contrary as experts had pointed out. He suggested that in the long term, the scientific community should think about ways to integrate the climate (and climate modelling) component into a larger framework related to the climate, society and the economy, where the climate is not just the outcome of prescribed emissions, but where levels of impacts to be avoided can be translated into emissions and policies, and where climate change influences technology and societal choices on mitigation and adaptation;

---

[11] Available at <http://www.unep.org/climatechange/adaptation/gapreport2014/>.

[12] Available at <http://www.unep.org/publications/ebooks/emissionsgapreport2014/>.

(d) The fourth message has to do with the need to translate the AR5 findings to regional and national levels. He added that understanding the implications of the 2 °C goal at the national level calls for, inter alia, a systematic observation system that has high spatial and temporal resolution to better support adaptation, a better understanding of how much climate change is taking place at the regional level and a focus on regions with the highest vulnerability.

15. After providing an overview of SED 4-2, he indicated he believes that the review process has already shown to be a successful and promising vehicle to inform and support policy formulation, taking into account various values, while recognizing that what constitutes an intolerable risk may differ across sectors, regions and countries. He also stressed that the review of the adequacy of the long-term global goal calls for science-based management of the emission pathway, including all the relevant dimensions of science. The collaboration between the SBSTA and the IPCC to ensure that such a science-based management of the pathway is carried out will be essential for this review and beyond. In this context, he remarked that the IPCC is currently discussing and agreeing on its future work, including on the terms of its next assessment cycle. He also mentioned decision 12/CP.20, in which the COP invited the IPCC to take into account the work of the UNFCCC in determining its future products and assessment cycles. He emphasized that this "may well bring about a further strengthening of the science–policy interface" enabling the science-based management of the pathway to a low-carbon, climate-resilient future.

16. In closing, Mr. Chruszczow emphasized that the SED represents a significant and promising step forward in terms of bringing together the science and policy worlds.

17. Mr. Amena Yauvoli, SBI Chair, also delivered some opening remarks, focusing on theme 2 of the 2013–2015 review, the overall progress made towards achieving the long-term global goal. He stressed the timeliness of the review of the long-term global goal within the UNFCCC process and global climate policy in general, noting that 2015 will be a key year for global action on climate change. He underlined that the accelerating growth in CO_2 emissions that has occurred since 2000 has implications for the probability of limiting warming to 2 °C above pre-industrial levels, based on the cumulative emissions since 1750. He cited findings of the IPCC AR5 indicating that total anthropogenic emissions of greenhouse gases (GHGs) have continued to increase from 1970 to 2010, with larger absolute decadal increases towards the end of this period, despite a growing number of climate change mitigation policies, and that 40 per cent of the cumulative emissions were emitted since 1970.

18. Mr. Yauvoli stated that a message emerging from the review relates to the feasibility of the 2 °C limit in the context of a risk management approach to decision-making on climate change. He said that, as presented by the IPCC at SED 3, limiting warming below 2 °C is still both technically and economically feasible, but requires fundamental changes and entails risks associated not only with climate impacts but also, for example, with technology development and diffusion, since they are needed at an unprecedented scale. He underlined that the urgency of these changes is exacerbated in order to achieve a 1.5 °C limit and stressed costs, technology lock-in, and loss and damage among the consequences of delayed action.

19. He then focused on the imperative to track the development, adoption, implementation and effects of policies and measures undertaken by countries to advance their transition to a low-carbon economy, and the shift to a science-based management of the pathway to a low-carbon future. He underlined the importance of achieving a more seamless process in the scientific assessment of progress made towards limiting temperature increase below 2 °C, pointing to the need for countries to translate global numbers to the national level, as well as to aggregate national contributions and assess their impact on the global pathway. In this context, he emphasized the relevance of the multilateral assessment process conducted under SBI.

20. Mr. Yauvoli provided an update on the international assessment and review process for developed country Parties, noting that the first round of the multilateral assessment process was held in Lima, in December 2014, with the multilateral assessment of the progress of 17 Parties included in Annex I to the convention (Annex I Parties) towards their emission reduction targets. He explained that the Party records for these 17 Parties would be published at the end of February 2015, and that the remaining Annex I Parties would be assessed at SBI 42 and 43. On the multilateral assessment of developing countries, he explained that 10 Biennial Update Reports (BURs) by developing countries had been received and posted on the UNFCCC website, and

that the process of international consultation and analysis (ICA) of BURs had been initiated, with the first round of the workshops under the SBI for the facilitative sharing of views expected in 2016–2017.

21. Among the objectives of the multilateral assessment, he cited: enhancing trust among countries regarding the extent of national action; determining the extent to which needed reductions are likely to occur as a result of existing approaches; improving targeting of international assistance and climate finance to address key barriers; and helping countries learn from one another's experience.

22. Mr. Yauvoli also pointed to remaining challenges in bringing together under the 2013–2015 review the best available information from science and national information available in reports from Parties and other processes under the Convention, noting that a number of reports from the multilateral assessment will not be available on time for them to be considered by the 2013–2015 review. He therefore called for carrying forward beyond the 2013–2015 review the link between national information and that from science, while expressing the hope that progress achieved under the 2013–2015 review could benefit future work relating to a science-based management of the global pathway towards a low-carbon and climate-resilient future, thereby strengthening the science–policy interface. Nonetheless, he said that the 2 °C goal has been catalysing many actions since Cancun, and that through the preparation by Parties of their intended nationally determined contributions (INDCs), action is expected to be further catalysed. Emphasizing the importance of transparency of national contributions for the robustness of the 2015 agreement, he said that the multilateral assessment process captures progress on emission reductions and that such a tracking system is needed. However the current tracking system for adaptation and means of implementation (MOI) is less mature than for mitigation, in part due to the scarcity of the needed information.

23. While noting that significant efforts have been made on adaptation, finance, capacity-building and technology transfer, he said they need to be strengthened. Mr. Yauvoli then reported on ongoing work on national adaptation plans (NAPs), which is carried out under the SBI. He explained that under the NAP process, each country determines the level of risk to which it seeks to adapt and coordinates the support required. NAPs will therefore be a key document on national adaptation needs and priorities, which may also include information on costs. He explained that the initial guidelines for the NAP process include a reporting, monitoring and evaluation element. It is therefore an ongoing process that will enable countries to formulate and update their adaptation plans and objectives regularly, in light of the emerging science. As such, he said, the NAP process will be part of the tracking of progress towards the long-term global goal as it relates to adaptation.

24. In closing, he stated that 2 °C is the internationally agreed upper limit for global warming that will guide and catalyse our future actions and raise ambitions, and that the review is a comprehensive process that looks at the climate 'problem' and 'solutions' in an integrated manner.

25. **Part 3** focused on information from United Nations agencies and international organizations, and from processes under the Convention. It started with a presentation by the Adaptation Committee (AC), which was followed by two presentations by: the Convention on Biological Diversity (CBD), addressing matters relating to the linkages between biodiversity and climate change mitigation and adaptation; and the United Nations Convention to Combat Desertification (UNCCD), focusing on desertification and land degradation and their impacts on natural ecosystems and food security. A final presentation illustrated the work of the SBI supporting adaptation and mitigation action through capacity-building including the role of education for mitigation and notably adaptation. The presentations were followed by a substantive discussion guided by questions.

26. SED co-facilitator, Mr. Fischlin, welcomed delegates to part 4 of SED 4 and explained that pursuant to a request by a group of Parties and Article 4, paragraph 8, of the Convention, this part would hear regional perspectives on the observed impacts of climate change. He emphasized that other organizations cannot compete with the IPCC in terms of the rigor of its review process, which is why the COP agreed to the AR5 being a key input into the 2013–2015 review.

27. **Part 4** focused on regional and emerging information. It started with presentations by regional centres in the Caribbean, Pacific and the Arctic, illustrating observed impacts of climate change in these regions, followed by a presentation on agriculture and food security in a changing climate with a focus on tropical regions. A final presentation by the World Meteorological Organization (WMO) illustrated emerging information on the state of the climate published after the AR5 cut-off dates. As in the previous three parts, the presentations were followed by a substantive discussion among experts and Parties guided by questions.

III. Summary of the discussion

A. Part 1: Introductory presentation on the Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

1. Presentations by experts

28. Ms. Renate Christ, Secretary of the IPCC, delivered a presentation on behalf of the Chair of the IPCC, which emphasized the added value of the integration and synthesis of the work of the three Working Groups of the IPCC. She outlined the key findings emerging from the AR5, including that: **human interference in the climate system is clear; the more we disrupt our climate, the more we risk severe, pervasive and irreversible impacts**; and **we have the means to limit climate change and build a more prosperous, sustainable future.**

29. Ms. Christ noted that **anthropogenic GHG emissions have increased** since the pre-industrial era, owing largely to economic and population growth.[13] These emissions are now higher than ever, with atmospheric concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) at levels unprecedented in at least 800,000 years. **Climate impacts are already occurring** and the changes in extreme weather and climate events observed since about 1950 have been linked to human influence and include a decrease in cold temperature extremes and an increase in warm temperature extremes, extremely high sea levels, and an increase in the number of heavy precipitation events.

30. She stressed that continued emissions of GHGs will cause further warming and changes in the climate system, and that continued warming increases the risks of severe, pervasive and irreversible impacts. She added that some risks are already considerable, even at a 1 °C global temperature increase above pre-industrial levels, and are high to very high for increases of 4 °C or more. People who are socially, economically, culturally, politically, institutionally or otherwise marginalized are the most at risk.

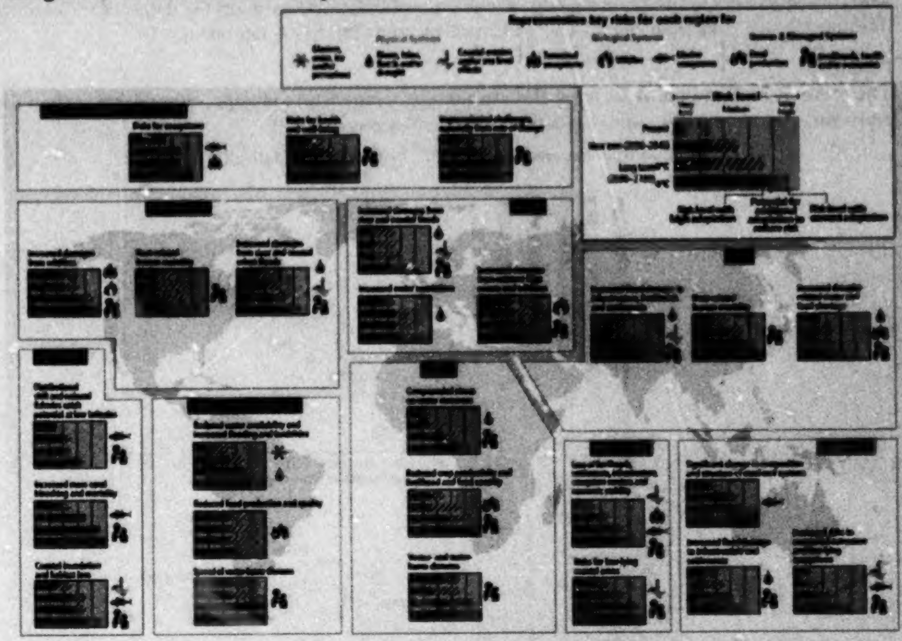
31. She explained that the **AR5 has assessed the risks at present, for the near term and for the long term**, considering, for the latter, warming of 2–4 °C above pre-industrial levels. This assessment of risks is presented by regions and by sectors, as well as for physical, biological, and human and managed systems. The IPCC has also assessed the potential for adaptation in terms of limiting the risks of climate change and the limits to adaptation (figure 56).

---

[13] See figure 12 and paragraph 110 of the summary report of SED 3, available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/sed3_summary_report.pdf>.

Figure 56

Representative key risks for each region, including the potential for risk reduction through adaptation and mitigation, as well as limits to adaptation



Source: Summary for policymakers in the Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.8. The figure shows representative key regional risks, assessed as very low, low, medium, high, or very high. Risk levels are presented for three time frames: present, near term (2030–2040), and long term (2080–2100). The long term is shown twice for a mean warming of 2 °C and 4 °C above pre-industrial levels.

32. Ms. Christ indicated that in the context of limiting temperature increase to 2 °C above pre-industrial levels, the AR5 has assessed that: a **combination of adaptation and substantial, sustained reductions in GHG emissions can limit climate change risks**; measures exist to achieve the substantial emission reductions required to limit likely warming to 2 °C above pre-industrial levels (**40–70 per cent reduction in GHGs globally by 2050, and near-zero or below-zero emissions levels in 2100**); implementing these GHG reductions implies various substantial technological, economic, social and institutional challenges; ambitious mitigation does not come without costs, but is affordable, and estimated costs do not account for the benefits of reduced climate change, and delaying mitigation will substantially increase the challenges associated with limiting warming to 2 °C above pre-industrial levels.

33. She outlined common **mitigation measures available**, such as: increasing: the efficiency of energy use; the use of low-carbon and no-carbon energy technologies, many of which already exist; improved carbon sinks such as bioenergy combined with carbon capture and storage (BECCS); and lifestyle and behavioural changes. She also mentioned the need to: **nearly quadruple zero- and low-carbon energy supply from renewable energy by 2050**, and to **reduce deforestation, improve forest management and plant new forests.**

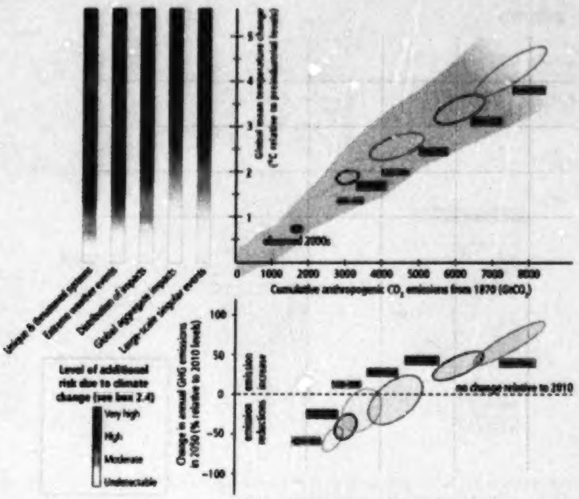
34. Ms. Christ emphasized that the link between **climate change and equity** has received a lot of attention and stressed the importance of assessing the issues of equity, justice and fairness raised by mitigation and adaptation action. In this respect, she highlighted different past and future contributions to the accumulation of GHGs in the atmosphere, different capacities to address mitigation and adaptation and varying challenges and circumstances. Capacities to address mitigation and adaptation vary, and insufficient adaptation would have a present impact on the potential for sustainable development. She added that options for equitable burden-sharing can reduce the potential for the costs of climate action to constrain development.

35. She introduced a graph illustrating the level of risks assessed by Working Group II (WGII) of the IPCC in its contribution to the AR5, including in regard to the five reasons for concern (RFC), for various levels of temperature increase (figure 57). *Mr. Stéphane Hallegatte, IPCC,* described how this figure connects actions with consequences for climate change by bringing together knowledge from the three IPCC Working Groups to illustrate that the risks from climate change depend on cumulative CO_2 emissions.

Figure 57

The relationship between risks from climate change, temperature change, cumulative carbon dioxide emissions and changes in annual greenhouse gas emissions by 2050

(A) Risks from climate change... (B) ...depend on cumulative CO_2 emissions...



(C) ...which in turn depend on annual GHG emissions over the next decades

Source: Summary for policymakers in the Synthesis Report the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.10. The figure shows the relationship among risks from climate change (panel A), temperature change and cumulative CO_2 emissions (panel B), and changes in annual GHG emissions by 2050 (panel C). See also figures 58, 59, 63, 64, 68 and 69 for additional explanations and considerations.

Abbreviations: GHG = greenhouse gas; 430–480 = scenarios leading to a concentration of 430–480 ppm CO_2 equivalent in 2100

36. He explained that limiting risks across the five RFC for a given increase in global mean temperature change (panel A) would imply:

(a) In the **long term, a limit for cumulative CO_2 emissions** (panel B). This panel brings together information from: Working Group I (WGI) models (pink plume), which include the uncertainty from non-CO_2 gases and climate and carbon uncertainty, using likely ranges; and Working Group III (WGIII) models for different categories of scenarios (ellipses), which do not include climate and carbon cycle uncertainty but explore more comprehensively the scenario's uncertainty for a range of CO_2 and non-CO_2 pathways, while considering cost effectiveness. While the carbon budget for a given increase in global mean temperature change could be estimated for average, high and low climate sensitivity (figure 58), the existence of a limited budget means that CO_2 emissions have to be reduced to zero to stabilize the global mean temperature;

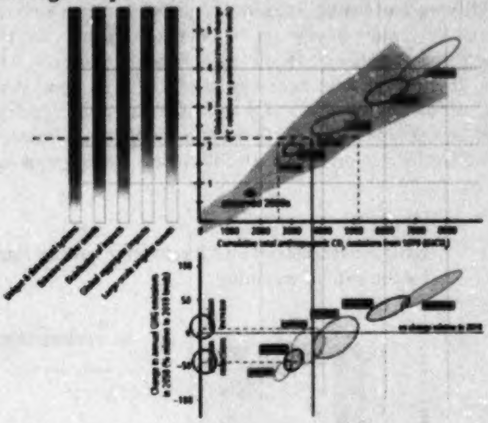
(b) In the **near term, a constraint for changes in annual GHG emissions in 2050** relative to 2010 (panel C). This constraint depends on the sensitivity of the climate response (figure 59). For example, considering high climate sensitivity the emission reductions in 2050 would be in the range of -70 to -50 per cent (see also figure 69 that shows these correlations for 2 °C warming above pre-industrial levels).

37. Mr. Hallegatte explained that figure 57 (IPCC SYR SPM.10) can also be used to determine, for a given level of reduction in the global emissions in 2050, the increases in global average temperature and the

corresponding levels of climate risks. For example, figure 59 presents these values for 10 per cent emission reductions in 2050. He added that the figure does not show the likelihood of staying below a limit temperature for any particular range for GHG concentrations in atmosphere by 2100. This is shown in SYR table SPM.1 and is discussed partially in paragraph 63.

Figure 58

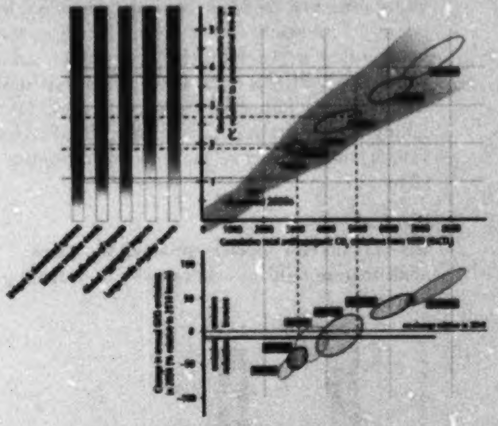
The carbon budget and the reductions in global emissions for a given level of increase in global average temperature



Source: Slide 16 of the presentation by Ms. Renate Christ (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed1-revisedrc_fin.pdf>. The figure illustrates how any levels of additional risks (top left, top dashed horizontal blue line) can be connected to GHG emission changes by 2050 (red circles) considering the best estimate (solid vertical blue line) and likely range of uncertainties from non-CO_2 gases, climate, and carbon cycle (dashed vertical blue lines). Added uncertainty arises from action on non-CO_2 gases, timing of pre-2050 action, and ambition of post-2050 action.

Figure 59

The global average temperature and the corresponding levels of climate risks for a given level of emission reductions in 2050



Source: Slide 22 of the presentation by Ms. Renate Christ (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed1-revisedrc_fin.pdf>. The figure illustrates how additional risks from climate change (top left, horizontal blue lines) depend on emission changes by 2050 (e.g. -10%, bottom horizontal solid blue line), but also on climate sensitivity and post-2050 action (here looking at average (dashed blue lines) and likely (thin dotted blue lines) range of climate sensitivity for ambitious (left vertical dashed blue line) and less ambitious (right vertical dashed blue line) post-2050 action).

B. Part 1: The adequacy of the long-term global goal in the light of the ultimate objective of the Convention and overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention based on the Synthesis Report of the Fifth Assessment Report

1. Presentations by experts

38. Mr. Hans-Otto Pörtner (IPCC) gave a presentation on the adequacy of the long-term global goal in terms of preventing unacceptable consequences for the adaptation of ecosystems and food production. He explained he would focus on Article 2 of the Convention, which contains its objective, including the stabilization of GHG concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system, and within a timeframe sufficient to allow ecosystems to adapt naturally to climate change and to ensure that food production is not threatened and economic development proceeds in a sustainable manner. He compared the affected sectors and long-term global goal with respect to key risks of impacts and avoided impacts.

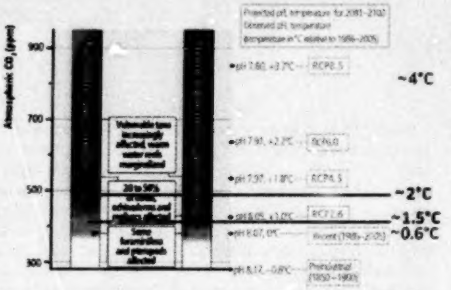
39. At the **current level of warming of 0.85 °C** above pre-industrial levels, impacts have been observed on all continents and in all oceans, including: **displacements of marine, freshwater and terrestrial species**;

constrained increases in crop production; forest dieback due to drought and heat; and **moderate risk from climate change to some unique systems**, which may rise if combined with other pressures. One of these systems is **warm water coral reefs**, which are under combined pressures, including the release of symbiotic algae and associated bleaching of coral due to warming. He cited the example of the Great Barrier Reef, which has already lost half of its live coral cover since 1985, due to cyclones, increased predation and bleaching.

40. With regard to **latitudinal shifts of coral reefs** he noted that, while such shifts have occurred in the last interglacial period with temperature increases of less than 1 °, coral reefs will be under additional stress from acidification constraining redistribution. Mr. Pörtner explained that marine organisms in general are increasingly under **pressure, as the oceans are warming, acidifying and losing oxygen**. He added that the combination of ocean acidification with warming increases the risk levels for marine species (figure 60). In a world 1.5 °C warmer than in pre-industrial times, we are on the verge of moving to high risk for these organisms, while in a world 2 °C warmer than in pre-industrial times, the risk already becomes high for these ecosystems. For freshwater and terrestrial species, in a world 1.5 °C warmer, most trees and herbs would be at moderate risk from falling behind the moving climate zones. However, in flat landscapes, 2 °C warming means that climate change velocity would become too high for terrestrial and freshwater organisms to follow the moving climate zones (figure 61).

Figure 60

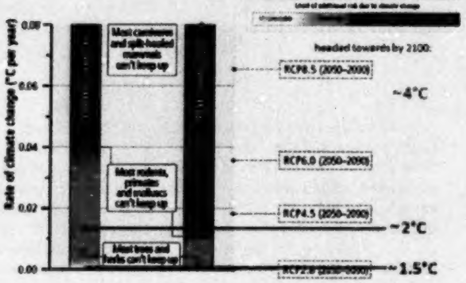
Risk for marine species impacted by ocean acidification only, or additionally by warming extremes



Source: Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 2.5, panel (B). The figure illustrates the increased risk for marine species when considering ocean acidification and heat exposure.

Figure 61

Risk for terrestrial and freshwater species impacted by the rate of warming



Source: Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 2.5, panel (A). The figure illustrates the species composition limited ability of terrestrial and freshwater ecosystems to follow the moving climate zones due to rate of warming.

41. On food security, Mr. Pörtner stated that at 2 °C of warming, **fisheries** will be under pressure from ocean warming, which will combine with the present overexploitation of stocks and with acidification and loss of oxygen. Although there is capacity to increase **crop production**, this has already been reduced because of climate change. In addition, in a world 2 °C warmer, even high adaptation will not be able to reduce risk to the currently low level.

42. He then turned to the **Arctic** summer sea ice and associated sea life, which is projected to be marginalized by mid-century in 'business as usual' scenarios. In an ambitious scenario, some of that sea ice may be preserved. As for **sea level rise**, with high mitigation and adaptation scenarios, we may limit global sea level rise to 1 m. Otherwise, sea level rise beyond 2100 may challenge natural and human systems, affecting habitat, freshwater resources and human society through flood events. He underlined that the sea level rose more than 7 m when the atmosphere had reached 400 ppm of CO_2 in the Pliocene (3–5 million years ago).

43. In concluding, he summarized the key findings of his presentation, highlighting that:

(a) In **a world 1.5 °C warmer** than in pre-industrial times: climate change velocity would be slow enough for most terrestrial and freshwater organisms to follow; up to half of coral reefs may remain intact; sea level rise may remain below 1 m; some Arctic summer sea ice may remain; ocean acidification impacts would stay at moderate levels; the capacity to increase food production would be reduced, but some scope would exist for adaptation; some unique systems would be at high risk; and the risks of combined ocean acidification and warming would become more prominent;

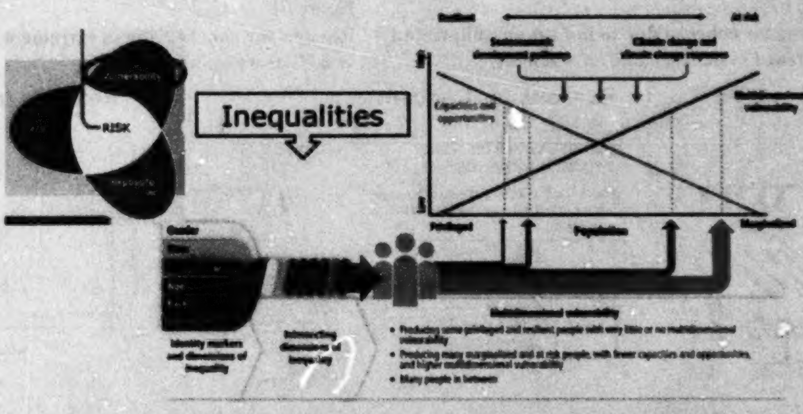
(b) In **a world 2 °C warmer** than in pre-industrial times: climate change velocity would become too high for some species to move sufficiently fast and follow their preferred temperatures; long-term sea level rise may exceed 1 m; Arctic summer sea ice may be lost; some unique systems would be at high risk; the risks of combined ocean warming and acidification would become high; and crop production would be at high risk with some potential for adaptation;

(c) In **a world 4 °C warmer** than in pre-industrial times: most projected climate risks for ecosystem would become impacts; biodiversity would be lost, and the catch potential of fisheries would be highly reduced; crop production would be at high risk; climate change velocity would be much too high for terrestrial and freshwater species to move sufficiently fast; long-term sea level rise would far exceed 1 m; Arctic summer sea ice would be lost; some unique systems would be marginalized; and the risks of combined ocean warming and acidification would become very high.

44. Ms. Petra Tschakert (IPCC) gave a presentation on the adequacy of the long-term global goal in terms of preventing the unacceptable consequences of climate change on sustainable economic development. She underlined that **sustainable economic development** can be **seen through** the lenses **livelihoods, food security, and economics**, and **is not only an outcome of climate change, but also shapes vulnerability to climate change.**

45. Differences in vulnerability and exposure to climate change arise from non-climatic factors and from multi-dimensional inequalities, which are often produced by uneven development processes. Development shapes inequalities and these inequalities shape differential risks from climate change (figure 62). **People who are socially, economically, culturally, politically, institutionally or otherwise marginalized are especially vulnerable to climate change** owing to multidimensional vulnerability, as well as owing to lack of capacities and opportunities for adaptation (right-hand side of figure 62).

Figure 62
Multi-dimensional inequalities



Source: Slide 3 of the presentation by Ms. Petra Tschakert (Intergovernmental Panel on Climate Change (IPCC)), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed4_tschakert_2.pdf>. The figure illustrates that multidimensional vulnerability is driven by intersecting dimensions of inequality, socioeconomic development pathways, and climate change and climate change responses (see also contribution of Working Group II to the Fifth Assessment Report of the IPCC, figure 13.5).

46. Ms. Tschakert stated that **climate-related hazards exacerbate other stressors**, such as socio-economic and environmental stressors, and have a negative impact on people and livelihoods, with the emergence of critical thresholds, when **all stressors converge.**

47. Regarding **future risks**, she noted that: climate change will amplify existing risks and create new risks for natural and human systems; risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development; and increasing magnitudes of warming increase the

likelihood of severe, pervasive and irreversible impacts for people, species and ecosystems. She pointed to those risks that are relevant to sustainable development, such as ill health, water insecurity, service and infrastructure, violent conflicts or poverty traps (see figure 56 for representative key risks and the potential for adaptation for human and managed systems in various regions).

48. Ms. Tschakert then detailed the RFC, with a focus on human and managed systems. **At the current 0.8 °C of warming** above pre-industrial levels, aggregated risks to **unique and threatened systems** indicate that indigenous people or other unique communities of peoples, such as Arctic communities and the Bolivian highlands, are already impacted by climate change.

49. For a **level of warming of 2 °C** above pre-industrial levels:

(a) Unique and threatened systems: many more moderate and high risks would emerge; indigenous people would be at risk of the loss of land, cultural and natural heritage; and cultural practices embedded in livelihoods would be disrupted (figure 63).

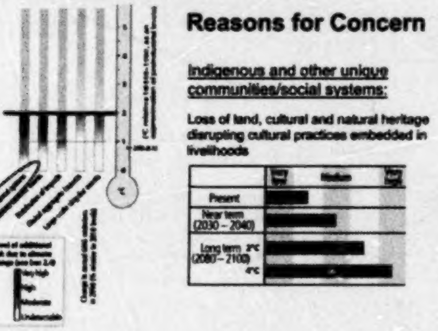
(b) **Extreme weather events**: high risks would exist for megacities in relation to the urban heat island effect, air pollution and differential vulnerabilities; urban housing and human health; displacement and permanent migration; livelihood struggles and conflict in resource-dependent livelihoods, such as agriculture and pastoralism; and high livelihood damage. She emphasized that 'trapped' populations are more vulnerable to environmental change because of their inability to move (figure 64, right-hand side of the figure);

(c) **Distribution of impacts**: she stressed that risks are increasingly unevenly distributed, affecting in particular: low-latitudes and low-income countries; shifts from transient to chronic poverty, and related social marginalization and food insecurity; and the elderly, children, the socially marginalized and outdoor workers, who are disproportionally at risk from heat stress;

(d) **Global aggregate impacts**: she underscored that while aggregate economic damages are quite moderate, these aggregates mask impacts across sectors and regions. She explained that the poor "are too poor to come up in the statistics" as they do not make a dent in the economic analysis. The evaluations are therefore incomplete, in part because they do not take into account large-scale singular events.

Figure 63

Reasons for concern due to impact on unique and threatened systems at 2 °C of warming



Reasons for Concern

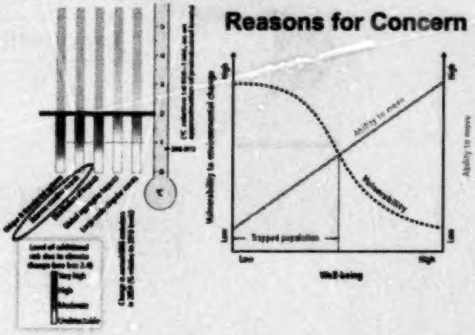
Indigenous and other unique communities/social systems:

Loss of land, cultural and natural heritage disrupting cultural practices embedded in livelihoods

Source: Slide 8 of the presentation by Ms. Petra Tschakert (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed4_tschakert_2.pdf>. The figure shows the level of additional risk due to climate change for large and unique systems, at 2 °C of warming above pre-industrial levels.

Figure 64

Reasons for concern due to extreme weather events at 2 °C of warming



Reasons for Concern

Source: Slide 10 of the presentation by Ms. Petra Tschakert (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed4_tschakert_2.pdf>. The figure illustrates the level of additional risk due to climate change for extreme weather events, at 2 °C of warming above pre-industrial levels.

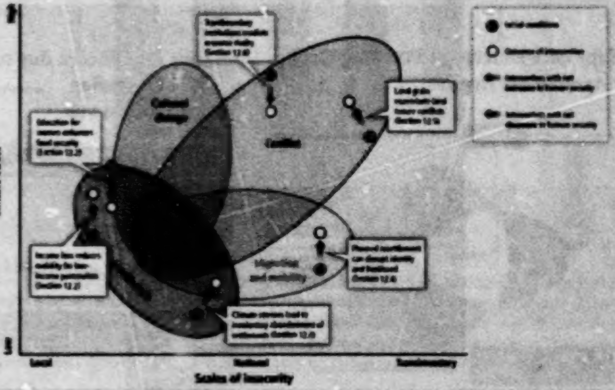
50. For a **level of warming of 3 °C** above pre-industrial levels, she mentioned limits to adaptation in relation to: urban water supply systems, heat-sensitive people, productivity, food security and the loss of cultural identity. In particular, she referred to the declining adaptation potential in case of conflict over land acquisition and displacement. There are few estimates of the economic costs of a **warming of 3 °C** above pre-industrial levels.

51. Ms. Tschakert emphasized the multiple interactions between climate stress and the scale of insecurity at the local, national and transboundary levels, highlighting the effects of, for example, income loss on mobility, education of women on food security, and planned resettlements on livelihoods (figure 65).

52. In concluding, she emphasized that: **climate change is a threat to equitable and sustainable development**; averages and aggregates mask disproportional impacts and risks; critical thresholds for communities and society exist and are not visible from a global average; critical thresholds of climate stressors in combination with other stressors exacerbate livelihood struggles, especially among disadvantaged people; **a possible yardstick to assess the level of risk would be the transition from acceptable to unacceptable at the local level**; and **limiting the effects of climate change is necessary to achieve sustainable development and equity, including the eradication of poverty.**

Figure 65

Interactions at multiple levels



Source: Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 12.3. The figure shows the synthesis of evidence on the degree of impacts of climate change (climate stress) and scales of human security as they interact for livelihoods, culture, migration, and conflict.

53. Mr. Chris Field (IPCC) and Mr. Ottmar Edenhofer (IPCC) delivered a joint presentation on the adequacy of 2 °C in terms of risk management within planetary boundaries and progress towards the long-term global goal.

54. Mr. Field introduced the concept of a '**black elephant**', which was described in an editorial by Mr. Thomas Friedman published in the *New York Times*. A 'black elephant', he explained, is a cross between a 'black swan', i.e. an unlikely, unexpected event with enormous ramifications, and the 'elephant in the room,' i.e. a problem that is visible to everyone, but that no one wants to address, even though we know that one day it will have vast, black-swan-like consequences. Mr. Field explained that climate change is a 'black elephant' problem as it combines: black swan risks, such as the collapse of the Antarctic ice sheet, which is a low-probability, high-impact event; and the elephant in the room, since it involves some elements that are difficult to assess, such as human population size, weak institutions and poor governance, inequality in income that marginalizes people, etc.

55. Ms. Katharine Mach (IPCC) briefly explained the concept of climate risks as introduced in the contribution of WGII to the AR5 (figure 66). She outlined key risks and the assessment of risks at present, near-term (approximately equivalent to a warming of 1.5 °C), and long-term (at 2 °C and 4 °C) with current and high adaptation. She also restated the WGII findings that an increasing magnitude of warming increases the likelihood of severe and pervasive impacts.

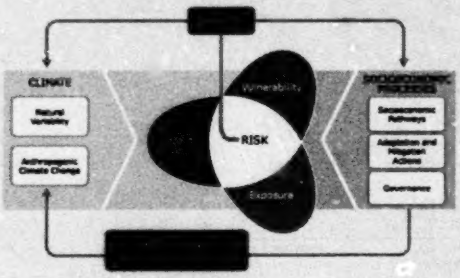
56. Ms. Mach stated that WGII assessed 102 key risks with low and high levels of adaptation. The SYR features 25 key risks across the regions of the world (see figure 56 for representative key regional risks). These risks are tied to physical, biological and human systems. She then introduced the concept on '**one unit of risk**', as being the transition of a risk from one level to the next (e.g. from very low to low or from medium to medium-

high). Noting that, using such a concept, **some 0.5 additional units of risks were estimated at 2 °C of warming above pre-industrial levels compared with 1.5 °C**, she stressed that for the latter, there is more scope for adaptation (figure 67). This type of analysis could extract additional information across regions and sectors for these two levels of global warming.

57. Ms. Mach pointed to an important caveat: the **near-term (2030–2040) and 2 °C in 2080–2100 are not strictly comparable**; some non-climate trends exacerbate risks; some non-climate trends moderate risks; and the risk assessment was not conducted by WGII for comparing the 1.5 °C and 2 °C targets. Mr. Field added that the **IPCC did not systematically assess risks due to warming levels between 1.5 °C and 2 °C above pre-industrial levels** owing to a lack of information, yet an analysis of the comparison between 1.52 °C and 2 °C shows that there are **consistent differences of about half of a risk unit or more**. In the light of the difficulty of predicting the black elephant risk, there is a value in **taking a precautionary approach and adopting a more stringent target**. Mr. Field underscored that across the risk analysis, investments in adaptation and the propensity for risk reduction are at risk of being overwhelmed.

Figure 66

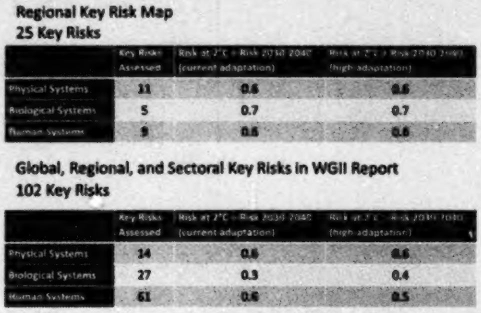
Illustration of the core concept of Working Group II in the Fifth Assessment Report



Source: Summary for policymakers in the contribution of Working Group II (WGII) to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change, figure SPM.1. The figure illustrates the constituents of risk being a combination of climate hazards, vulnerability, and exposure – the fundamental concept used throughout AR5 by WGII.

Figure 67

Reasons for concern due to extreme weather events at 2 °C of warming



Regional Key Risk Map
25 Key Risks

	Key Risks Assessed	Risk at 2°C – Risk 2030-2040 (current adaptation)	Risk at 2°C – Risk 2080-2100 (high adaptation)
Physical Systems	11	0.6	0.6
Biological Systems	5	0.7	0.7
Human Systems	9	0.6	0.6

Global, Regional, and Sectoral Key Risks in WGII Report
102 Key Risks

	Key Risks Assessed	Risk at 2°C – Risk 2030-2040 (current adaptation)	Risk at 2°C – Risk 2080-2100 (high adaptation)
Physical Systems	14	0.6	0.6
Biological Systems	27	0.3	0.4
Human Systems	61	0.6	0.5

Source: Slide 6 of the presentation by Ms. Katharine Mach (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/field_for_sed_12-2014.pdf>. The figure shows the increase in risks for key, global, regional and sectoral risks at 2 °C of warming above pre-industrial levels, with current and high adaptation (expressed in units of risks).

58. Mr. Edenhofer focused on a future pathway for adaptation, mitigation and sustainable development. In this context he emphasized that: (i) the **optimal balance among mitigation, adaptation and residual impacts cannot be determined with current knowledge**; (ii) **risks from adaptation and mitigation can be identified and managed through appropriate mitigation and adaptation measures**; and (iii) **mitigation and adaptation are complementary approaches for reducing climate change impacts over different timescales.**

59. Mr. Edenhofer added that if current emissions trends continue, even with adaptation, warming by the end of the twenty-first century will lead to high to very high risk of severe, widespread and irreversible impacts globally. Figure 68 shows these risks for a range of temperature increases corresponding to a 'business as usual' scenario and a median climate response. He then noted that, considering the full climate uncertainty, the minimum temperature increase might be lower, but the maximum temperature increase might also be much higher and significantly beyond what was assessed by IPCC (figure 68, top red arrows).

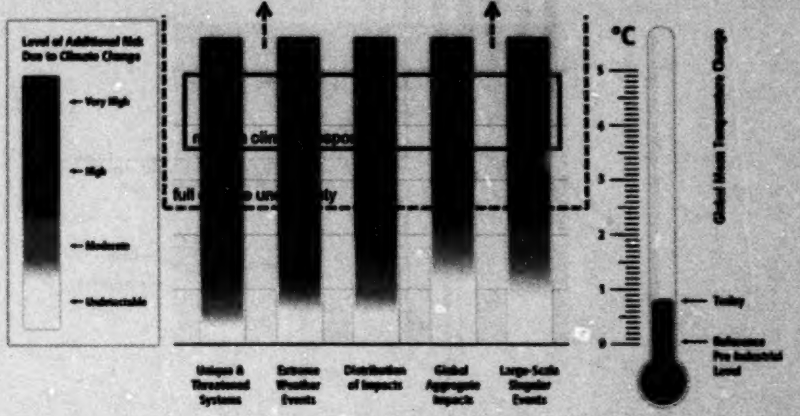
60. Mr. Edenhofer then explained that the IPCC explored the implications of a world warmer by 4 °C and 2 °C above pre-industrial levels, noting that the **1.5 °C limit is similar to the 2 °C one, but calls for additional scaling up of the challenging features** (see also paragraph 66).

61. Substantial cuts in GHG emissions over the next few decades, which would limit global warming below 2 °C, can significantly reduce risks of climate change by limiting warming in the second half of the twenty-first century and beyond (figure 68, risks at a 4.7 °C level of warming above pre-industrial levels compared with a

2 °C warming). Mr. Edenhofer stressed that mitigation action has co-benefits, but also risks. However, the **risks of mitigation do not involve the possibility of severe, widespread and irreversible impacts, as do the risks from climate change impacts.** He added that stabilization of atmospheric concentrations requires moving away from the baseline, or the 'business as usual' scenario, even for a less ambitious mitigation goal.

Figure 68

Climate risks for 'business as usual' scenarios



Source: Slide 2 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141202_sed_edenhofer_lima_final4.pdf>. The figure shows the level of risks associated with reasons for concern without additional mitigation efforts beyond those in place today, and even with adaptation. Mr. Ottmar Edenhofer emphasized the uncertainties contained in these risk estimates, if fully considered mean possibly lower risks (bottom horizontal dashed line) but also very much higher risks (top red arrows) that even reach beyond what was assessed by IPCC.

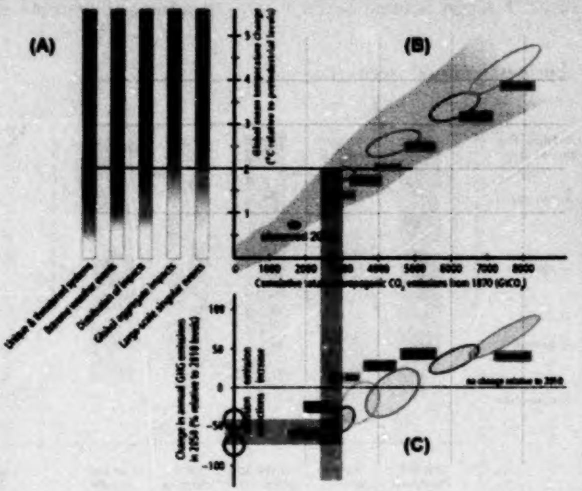
Abbreviation: BAU = business as usual

62. Mr. Edenhofer emphasized that cumulative emissions of CO_2 will largely determine global mean surface warming by the late twenty-first century and beyond. Limiting risks across RFC would imply a limit for cumulative emissions of CO_2. He underscored that the IPCC had found with high confidence that such a limit would require that **global net emissions of CO_2 decrease to near zero or below by 2100** and would constrain annual emissions over the next few decades. He cautioned, however, that some risks from climate damages are unavoidable, even with mitigation and adaptation.

63. Mr. Edenhofer then illustrated how figure SPM.10 of the AR5 SYR could be used to determine the reductions in **global emissions by 2050 needed to limit global warming to 2 °C, with a likely** probability. Considering the 430–480 category of scenarios in figure 69, this indicates an emission reduction range of **40–70 per cent in 2050 compared with 2010 levels**, clarifying that use of CO_2 **removal technologies will be much more needed for a 40 per cent than a 70 per cent reduction.**

Figure 69

The relationship between risks from climate change, temperature change, cumulative carbon dioxide emissions and changes in annual greenhouse gas emissions by 2050 for 2 °C warming

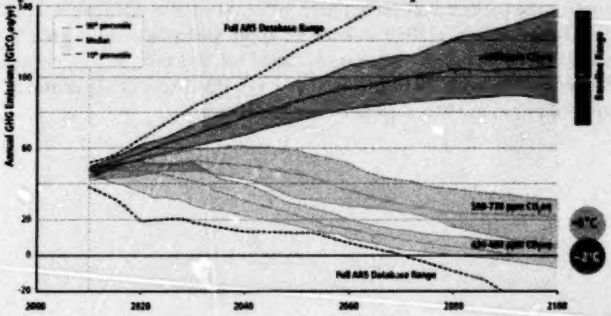


Source: Slide 6 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141202_sed_edenhofer_lima_final4.pdf>. The figure shows the relationship among risks from climate change (panel A), temperature change and cumulative CO_2 emissions (panel B), and changes in annual GHG emissions by 2050 (panel C), here illustrating a 2 °C of warming above pre-industrial levels (horizontal grey line) that corresponds to a 40 per cent to 70 per cent reduction in GHG emissions by 2050 (red circles) while implying a GHG concentration of 430–480 ppm CO_2 equivalent in 2100 through suitable post-2050 action.

64. With regard to **stabilization of atmospheric concentrations**, he stressed that this requires moving away from the baseline, regardless of the mitigation goal (figure 70). Both the scenarios for limiting global warming below 2 °C and below 3 °C require a fundamental departure from the 'business as usual' scenario and, in the short term, similar global emission reductions are needed. Scenarios leading to 1.5 °C warming (being consistent with the lowest range of the blue strip) would require more negative emissions.

Figure 70

Stabilization of atmospheric concentrations of carbon dioxide equivalent



Source: Slide 7 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141202_sed_edenhofer_lima_final4.pdf>. The figure shows the GHG emission pathways up to 2100 for a 'business as usual scenario' (red), and for 3 °C (yellow) and 2 °C (blue) of warming above pre-industrial levels.

Abbreviation: GHG = greenhouse gas.

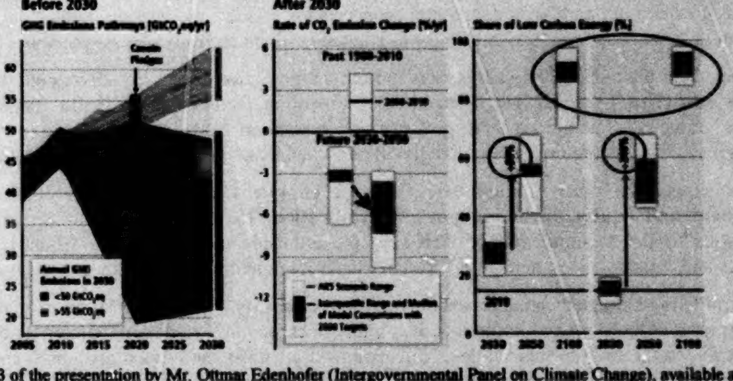
65. Mr. Edenhofer highlighted the increased challenges of delayed mitigation pathways – particularly between 2030 and 2050. He stressed that **immediate action** before 2030 would widen options for multiple cost-effective mitigation pathways (figure 71, left-hand side panel) that are characterized by average annual CO_2 emissions reductions of about 3 per cent (middle panel) and would require roughly a doubling of the share of low-carbon energy technologies between 2030 and 2050 (right-hand side panel). **Delaying mitigation** increases the difficulty and narrows the options for limiting warming to 2 °C above pre-industrial levels. Scenarios with delayed mitigation action that can still achieve the 2 °C limit require a more ambitious mitigation profile after 2030. Average annual CO_2 emission reduction requirements increase to about 6 per cent between 2030 and 2050, and the share of low carbon energy technologies need to be more than tripled, which has significant risks. In this context, he emphasized that for reaching the 2 °C limit the Cancun pledges are only consistent with emission pathways that show such increased mitigation challenges.

66. **On the 1.5 °C limit**, he underscored that scientific evidence remains limited. While recognizing that a comprehensive assessment of this limit is difficult in the absence of multi-model comparison studies and with the overall limited number of studies, he outlined four characteristics of the existing studies of this limit, namely: (i) temperature overshoot and large-scale application of CO_2 removal technologies; (ii) immediate mitigation action; (iii) rapid scaling up of the full set of technologies; and (iv) the development along a low-energy demand pathway.

67. **On the costs of mitigation**, Mr. Edenhofer stated that although cost estimates vary significantly, they do not strongly affect global gross domestic product (GDP) growth; therefore, climate policy can be reconciled with economic growth. Global costs rise with the ambition of the mitigation goal.

Figure 71

Delaying mitigation increases the difficulty and narrows the options for limiting warming to 2 °C



Source: Slide 13 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141202_sed_edenhofer_lima_final4.pdf>. The figure summarizes the implications of greenhouse gas emission levels in 2030 (left) for the subsequent rates of CO_2 emission reductions (middle) and scaling-up of low-carbon energy (right) needed for mitigation scenarios reaching 450–500 ppm by 2100 comparing Cancun Pledges (light green) with more ambitious mitigation actions by 2030 (dark green).

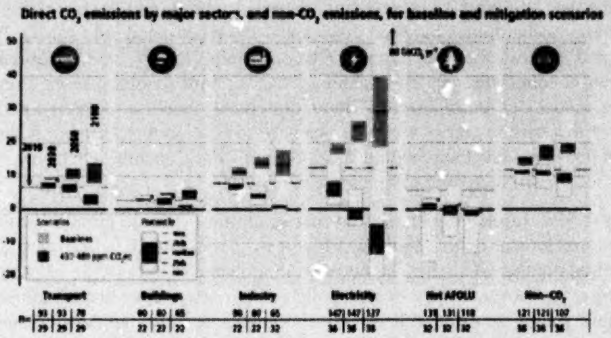
Abbreviation: GHG = greenhouse gas

68. In concluding, he emphasized that climate change is a global commons problem, which requires international cooperation and coordination. He stressed that for the twenty-first century, the limiting factor is not the amount of fossil fuel in the ground, but the limited disposal space in the atmosphere, which is why low-stabilization pathways are so demanding in terms of technological and institutional requirements.

69. Mr. Ramón Pichs-Madruga (IPCC) presented key findings summarized in the AR5 SYR on climate policies, technologies and finance. He emphasized that the previous presentations had shown that: a combination of adaptation and substantial and sustained mitigation can limit climate change risk; there are important technological, economic, social and institutional challenges related to climate response; and delaying mitigation will substantially increase challenges and costs related to limiting warming. He emphasized that **well-designed systemic and cross-sectoral mitigation strategies are more cost-effective in cutting emissions than a focus on individual technologies and sectors** (figure 72).

Figure 72

Cross-sectoral mitigation strategies are more cost-effective than a focus on individual technologies or sectors



Source: Summary for policymakers of the Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.14. The figure shows CO$_2$ emissions by sector and total non-CO$_2$ greenhouse gas emissions (Kyoto gases) across sectors for the baseline (faded bars) and mitigation scenarios (solid-colour bars) by 2030, 2050, and 2100 that reach about 450 ppm CO$_2$ eq concentrations in 2100.

Abbreviation: GHG = greenhouse gas

70. Emphasizing that **adaptation and mitigation are complementarity response strategies**, Mr. Pichs-Madruga said substantial emission reductions over the next few decades could reduce climate risks in the twenty-first century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the long term, and contribute to climate-resilient pathways for sustainable development.

71. He added that while many adaptation and mitigation options can help address climate change, **no single option is sufficient by itself**. He listed common enabling factors that underpin adaptation and mitigation responses: effective institutions and governance, innovation and investments in environmentally sound technologies and infrastructure, sustainable livelihoods, and behavioural and lifestyle choices.

72. He emphasized that limiting the effects of **climate change** is necessary to achieve **sustainable development and equity, including poverty eradication**. He pointed out that countries' past and future contributions to the accumulation of GHGs in the atmosphere are different. Countries also face varying challenges and circumstances, and have different capacities to address mitigation and adaptation.

73. Mr. Pichs-Madruga then addressed the questions of **equity, justice and fairness** related to climate change responses, such as those related to the fact that: many of those most vulnerable to climate change are those who have contributed the least to this challenge; delaying action shifts the burden to future generations; insufficient adaptation responses to emerging impacts are already eroding the basis for sustainable development; and evidence suggests that outcomes seen as equitable can lead to more effective cooperation. He stated that cooperative responses, including international cooperation, are therefore required to effectively mitigate GHG emissions and address other climate change issues. Furthermore, he emphasized that the effectiveness of adaptation can be enhanced through complementary actions across levels, including international cooperation.

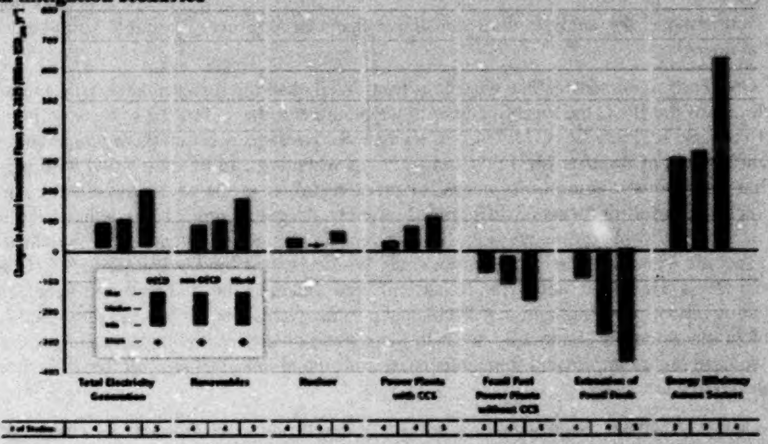
74. On **policies, technologies and finance**, Mr. Pichs-Madruga stated that effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and subnational. Policies across all scales, supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation. Substantial reductions in emissions would require large changes in investment patterns (figure 73).

75. In concluding, Mr. Pichs-Madruga focused on the relationship between climate change responses and sustainable development, emphasizing that comprehensive strategies in response to climate change that are consistent with sustainable development take into account the co-benefits, adverse side-effects and risks that may arise from both adaptation and mitigation options. He stressed that the IPCC found with high confidence that there are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through

integrated responses. The IPCC also found with medium confidence that successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond.

Figure 73

Change in annual investment flows from the average baseline level over the next two decades for 430–530 ppm mitigation scenarios



Source: The Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 4.4. The figure shows change in annual investment flows from the average baseline level over the next two decades (2010 to 2029) for mitigation scenarios that stabilize concentrations (without overshoot) within the range of approximately 430–530 ppm CO_2 eq by 2100.

Abbreviations: CCS = carbon capture and storage; OECD = Organisation for Economic Co-operation and Development.

2. General discussion

76. The ensuing discussion was guided by the following questions on theme 1 of the review:

(a) What are the salient messages from the AR5 SYR relevant to the 2013–2015 review? What are the strategies for risk reduction and for managing adaptation and mitigation? What is the relationship among risks of climate change, cumulative CO_2 emissions and annual GHG emissions over the next decades?

(b) How does the AR5 contribute to operationalizing Article 2 of the Convention, including with regard to anthropogenic interference with the climate system and associated risks or dangers to food production, sustainable economic development and ecosystem adaptation? How do these risks grow as we move from 1.5 °C to 2 °C of global warming? What does the AR5 SYR tell us about limiting global warming to 2 °C?

77. Mr. Fischlin suggested Parties focus on how the SED operationalizes Article 2 of the Convention, and addressed questions such as: what does dangerous interference mean? If value judgment has to be introduced to determine the acceptability of risk, how adequate is the long-term global goal? By when, and by how much, do we have to mitigate and foster adaptation? Are there barriers or enablers we should pay attention to?

78. A Party welcomed the **comparison of impacts between 1.5 °C and 2 °C** of warming above pre-industrial levels. She asked **why in aggregate there is only a one half point increase in risk between a 50 per cent** (at 1.5 °C) **and a complete loss** (at 2 °C) **of coral reefs**. The expert clarified that he was talking about a marginalization of coral reefs, not their total disappearance, and the degree of this marginalization. Some organisms may not become completely extinct but may not to be able to provide the services they are currently providing. He added that this can mark a difference between the local and the global views, as the degree of risk change between 1.5 °C and 2 °C may be much greater for the affected regions than at the global level.

79. One Party noted that "we are already facing a lot of trouble", emphasizing that even at 1.5 °C of warming above pre-industrial levels, risks to unique and threatened systems are assessed as high. He added that climate impacts are catastrophic for his country, and that **qualifying the risks related to the distribution of impacts as "moderate" is not convincing**. An expert explained that in the regional chapter of AR5 (the Oceans and

Australasia), the IPCC has assessed the risks to coral reefs as high in the near term and very high for the two regions in the long term at 2 °C of warming, emphasizing the regional differences in the assessment of risks to these ecosystems. In response to a request for clarification on the level of risk associated with the distribution of impacts, the expert explained that the level of risk is related to the number of causal links that the IPCC was able to assess in developing the RFC. For a given country, coral reefs may be essential to the lifestyle pursued, but the IPCC would not be able to make the necessary connections because the assessment is not carried out at that level. Furthermore, the analysis does not allow characterizing every possible combination of risks that has potential impacts.

80. One Party commented that we know from WGI that for representative concentration pathway (RCP) scenario 2.6 of the IPCC the mean increase in temperature at the end of the century will be 1.6 °C (0.9–2.3 °C) and for scenario RCP4.5 2.4 °C (1.9–4.2 °C). Given the overlaps between these temperatures, he asked how the **differential level of impacts for 1.5 °C and 2 °C of warming can be quantified with any level of certainty**, and **what the scientific community needs for more certainty in the next assessment cycle of the IPCC for a more accurate result in terms of differential impacts**. An expert replied by emphasizing the importance of the caveat mentioned in his presentation on the different timeframes of impacts. He explained that WGII "took a cut" at specific examples where risk levels could be ascertained for a warming of 1.5 °C and 2 °C above pre-industrial levels. He added that there are currently few examples in the literature to characterize risks between these two levels of warming, and that WGII made some extensions beyond the published literature. For future assessment, the scientific community needs to focus more on differential impacts. He stressed that at the present stage, we have few examples and some interesting conceptual links that suggest the differences, but they are only documented in a few cases.

81. On Ms. Tschakert's presentation, one Party asked about the **impacts of climate change on poverty reduction** and, quoting chapter 13 of the WGII report, he stated that climate change is expected to slow down economic growth and make poverty reduction more difficult for a warming of 2 °C, in particular in vulnerable countries. He then asked for a confirmation that a warming of 2 °C represents a substantial threat to the sustainable development of most the vulnerable countries. In response, the expert confirmed this finding of the WGII report.

82. Another Party asked if literature published after the IPCC cut-off dates on the **possible collapse of the West Antarctic Ice Sheet** may alter the assessment of the IPCC in relation to the risk of this large-scale singular event. An expert replied that it is too early to draw conclusions as there is no assessment of this literature yet. Another expert added that the current understanding is insufficient to make the assessment, and that the AR5 findings would not change with the few articles published after March 2013.

83. One Party asked the **extent to which risk can be reduced through adaptation**, noting that **other stressors also impact vulnerability and exposure**, such as socioeconomic pathways and governance. An expert responded that some risks have a lot of space for adaptation, while others have little. Key risks that have less adaptation potential relate to ecosystems where human interventions lead to reaching a limit, or when a relatively low physical or biological boundary was reached. Those are areas where addressing vulnerability or exposure has little prospect to make a difference. He added that assessing prospects for adaptation is still "a very imprecise science".

84. One Party asked, in the context of the options for staying under 2 °C of warming and of global GHG emissions approaching zero or below zero in 2100 for scenarios limiting warming below 2 °C, **what will be the pathways for non-CO_2 emissions**. He also asked how agricultural emissions and non-CO_2 gases should be considered when determining the desired level of emissions in 2100. An expert explained that although reducing non-CO_2 emissions can be an important element of mitigation strategies, the cumulative budget of CO_2 emissions determines the temperature, and long-term warming is mainly driven by CO_2 emissions.

85. In response to a question by one Party on how the IPCC is emphasizing the role of **indigenous knowledge** in adaptation, an expert stressed that while adaptation can relate to infrastructure, there are other approaches to adaptation such as structural institutional and social measures (see table SPM.1 of AR5 WGII). Among social measures, there are specific adaptation measures referring to learning and knowledge sharing, with use of indigenous knowledge and participatory action. She added that the IPCC emphasized the importance of a co-production of knowledge that includes indigenous knowledge. Another expert underlined that, to date, the application of indigenous knowledge has been "spotty".

86. One Party noted the need for a process to assess progress towards the long-term global goal, and asked how one should consider the adequacy of the long-term global goal in the light of **past and present contributions**. He suggested assessing the adequacy of the long-term global goal, including long-term perspectives, based on a **temperature increase approach**, and considering past and future contributions. One expert underscored that the IPCC provided information consistent with its mandate, and cannot go beyond this mandate to determine what the long-term goal should be or how to translate this goal into risks. Another expert added that the IPCC cannot make a value judgment related to historical responsibility. He pointed to the AR5 chapter on historical emissions, ethical issues and equity. On the choice of appropriate metrics and the global warming potential, he explained that the IPCC has evaluated the pros and cons of various metrics, referring to chapters 2, 3 and 6 of the contribution of WGIII to the AR5.

87. The ensuing discussion was guided by the following questions on theme 2 of the review:

(a) We heard from the IPCC that increasing magnitudes of warming will increase severe, widespread and irreversible impacts of climate change. In the light of this, what are the risks assessed by your organization on human health, food production and other ecosystem services at a 2 °C or 1.5 °C level of global mean warming compared with pre-industrial levels, and how does your organization contribute to reducing and managing these risks?

(b) What is the gap between current mitigation and adaptation efforts and those required to achieve the long-term global goal as characterized by a 2 °C or 1.5 °C level of warming relative to pre-industrial levels? How can this gap be bridged?

(c) What policy options has your organization identified for the decarbonization of the energy system called for by pathways consistent with limiting warming below 1.5 °C or 2 °C compared with pre-industrial levels? What are the economic and technological risks associated with this decarbonization?

(d) How effective have the steps taken by your organization been in terms of supporting national activities aimed at minimizing the impacts of climate change? What barriers have your organization encountered and how has it succeeded in overcoming them?

(e) Which policies and measures has your organization identified as effective to bridge the emissions and adaptation gap, and how can these policies and measures be emulated?

88. One Party asked if the information presented came from the various contributions of the Working Groups, or only from the SYR. Pointing to **differences between the carbon budget and emission reductions for remaining under 2 °C of warming presented by WGI** (14–96 per cent in 2050 below 1990) **and WGIII** (40–70 per cent in 2050 below 2010). He also asked how this information can be used for decision-making. An expert clarified that the requirement to reduce emissions by 40–70 per cent by 2050 to reach the long-term global goal is to be read with the "cost effectiveness" qualifier. He added that the main difference between WGI and WGIII findings comes from the fact that WGIII focused on cost-effective emission reduction profiles while considering explicitly societal uncertainties, such as delaying actions or availability of technologies. Another expert clarified that the uncertainty range (14–96 per cent in 2050 below 1990 with median 50 per cent) shown in the figures presented by WGI is related to the uncertainty in geophysical response and is based on the assessment of one scenario (scenario RCP2.6). While these uncertainties are taken into account in the assessments reported in the SYR, WGIII and the SYR further report an uncertainty range (40–70 per cent in 2050 below 2010) that is based on scenario and societal uncertainties while considering cost effectiveness. Further hedging against the geophysical uncertainty range reported by WGI would then imply deeper emission reductions by 2050 than those ranges currently reported by WGIII.

89. The same Party also asked **why observed impacts of climate change were not presented at this meeting** and if IPCC experts had presented graphics showing the amount of emissions of countries according to different development levels. An expert indicated that there is no slide on impacts that have already occurred, although these are relevant to the assessment of future risk, but these are changes that occurred at global warming of less than 1 °C. Further, he noted that the set of impacts that have been attributed so far to climate change is strongly constrained by the available studies. Another expert said no graphics relating to different levels of development had been presented.

90. **On managing risk**, one expert explained that it involves **reducing vulnerability and exposure** through, for example, human development, increasing livelihood security, poverty alleviation, ecosystem management or disaster risk reduction.

91. One Party asked **how the assessment of the RFC on distribution of impacts could be moderate if climate risks for Africa in the regional chapter are assessed as high or moderate**. An expert explained that RFC are an average or an aggregate of risks, and do not refer to any specific region. She pointed to the AR5 chapter on Africa, which confirms that any regional summary cannot be captured in the global summary because of the strong regional and sectoral differences (the aggregate level masking regional and sectoral differences) (see also para. 49 and 52 above).

92. One Party referred to the mapping of cumulative CO_2 emissions, commenting that about 275 Gt CO_2 could be further emitted while limiting temperature rise to 1.5 °C, which according to their calculation would mean that **only 7.9 years of emitting GHGs at current levels remains**. One expert said that when the temperature bar is lowered, there is a double change: more action is required to reduce emissions sooner, and more action is needed to achieve negative emissions. The calculation of the number of years of emissions disregards the possibility to have negative emissions, and makes the challenge seem greater than it probably is. The same Party then asked about the likelihood of achieving such negative emissions. One expert underscored that WGIII presents scenarios without likelihoods and that achieving negative emissions is an underlining requirement for 1.5 °C stabilization pathways. He added that if some technology is not yet available, the IPCC drew the consequences in terms of increased costs and of the feasibility of limiting warming. Another expert underlined that some technologies can come with trade-offs on land use, and that the scenarios also depend on the choices made regarding these trade-offs, not only on the availability of technologies.

93. One Party asked about the **practicality of achieving negative emissions at the end of the century**. He also queried whether making no assumptions on this practicality would affect the scenarios. An expert responded that achieving negative emissions depends on costs, trade-offs and the feasibility of various scenarios. He stated that WGIII did not come up with a conclusion regarding trade-offs, including on biodiversity, as it is up to decision makers to take into account factors related to bioenergy, which are outlined in an annex to the WGIII report. If bioenergy with CCS is not available (BECCS), mitigation costs increase. Furthermore, the more stringent the target, the more one needs to rely on other carbon removal technology. With respect to energy supply, the most risky part related to the technology availability of CCS relates to storage technologies, which have not been assessed in detail. Another important element is the fact that if CCS is available, agriculture emissions reductions can be more moderate. If BECCS is not available at a large scale, the land use and forestry sector has to make a larger contribution to the mitigation effort.

94. One Party asked about the **global costs associated with adaptation and loss and damage**, and if an assessment of the **costs of MOI** had been carried out. An expert underlined the difficulty of distinguishing between the costs of adaptation and the costs of residual impacts. He added that directly comparing the cost figures in WGII and WGIII reports would be "very misleading", since the cost of climate change in WGII is for limited warming (2 °C), i.e. for scenarios in which ambitious mitigation takes place, at a cost. So mitigation and climate change costs need to be added, more than compared. Moreover, these two estimates have their limits and problems, and should be used with care. The IPCC consensus is that these numbers are insufficient to determine the appropriate objective of global climate policy.

95. One Party commented that in order to consider the adequacy of the long-term global goal, one needs to consider at least three aspects, namely **risks at a certain temperature goal, avoided impacts** that would be achieved and the **feasibility** of this long-term global goal. She requested a clarification as to why he had used scenario RCP2.6 to identify the impacts of 1.5 °C of global warming, considering that this scenario was usually representative of the 2 °C limit. She added that there is limited likelihood of achieving the 1.5 °C limit. The expert explained that he used scenario RCP2.6 because it is the closest to 1.5 °C limit, despite exceeding it. The expert added that he also based the presented findings on other scenarios and sources, not only using scenario RCP2.6 based data. Another expert added that WGI provided a likely range for each scenario, and that for scenario RCP2.6, it gives a likely range of not exceeding 2 °C. He emphasized that WGI did not assess the likelihood of staying below 1.5 °C.

96. One Party asked if in the figure 69 representing the levels of risk for the various **RFC**, the IPCC had **considered adaptation**. An expert explained that the graph does not make specific assumptions on adaptation,

and that the purple colour in the figure is associated with the difficulty of making progress on adaptation. Another expert added that all RFC take into account autonomous adaptation as well as limits to adaptation in the case of RFC1, RFC3 and RFC5, independent of the development pathway, as detailed in the caption to figure 19.4 of the WGII report.

97. **On figure 57** (figure SPM.-10 in the AR5 SYR), one Party asked if **the numbers had been set without considering uncertainties**, such as the likelihood for achieving a temperature limit and the availability of technologies and technology transfer. An expert pointed to references in the AR5 to technology policy and how it complements other policies. The AR5 includes assessments of the costs of various technologies, which could serve as input in considering these technologies and their risks.

98. In response to a question on the **adverse effects of various mitigation technologies**, an expert drew attention to the fact that in the AR5, the IPCC had considered various enabling factors for technology transfer, including institutional arrangements, the provision of finance and the capacity to absorb the technologies adapted to each region.

99. On risk framing and the concept of high adaptation, one Party said that he understood from SED 3 that **high adaptation only has physical and not social or economic constraints**; hence it refers to transformational adaptation, which includes measures such as forced relocation. He added that such a measure is not an option for his country, as it implies fundamental changes in livelihoods and cultural values. An expert clarified that there was no WGII-level guidance that prevented authors from considering relocation as an adaptation option. The definition of a highly adaptive state was left with the writing team to assess, depending on the cultural environment.

100. On the **different costs of achieving the 1.5 °C and 2 °C limits**, one Party noted that the 1.5 °C scenarios require a faster deployment of low-carbon technologies, which imply a higher cost, but that the IPCC had not assessed the costs of these mitigation scenarios. An expert replied that IPCC cost-effective scenarios start with effective mitigation scenarios before 2020. Delayed mitigation action translates to more mitigation costs. He added that the IPCC only reported on the mitigation costs for stabilisation levels analysed in a multi-model, inter-comparison exercise. Since no such multi-model exercises were available for the 1.5°C limit, the mitigation cost was not provided.

101. A representative of civil society asked if it is correct to assume that **if optimal conditions are not achieved in terms of the availability of technologies, zero net emissions would have to be reached earlier than 2050**. She added that CCS is much discussed and not much deployed, prompting questions regarding the implications of its unavailability. An expert pointed to AR5 SYR table SPM.-2, which indicates that mitigation costs increase where CCS is unavailable. He underscored that not all models are successful in carrying out a scenario reaching the 2 °C limit without the wide-scale deployment of CCS. The limited availability of technology leads to the infeasibility of the target or a cost increase.

C. Part 2: The adequacy of the long-term global goal in the light of the ultimate objective of the Convention and overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention based on information from United Nations organizations

1. Presentations by experts

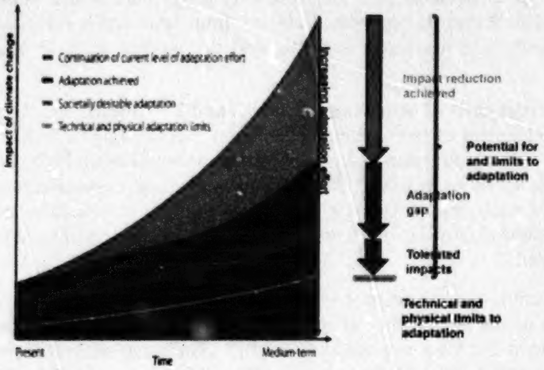
102. Mr. Keith Alverson (UNEP) presented the 2014 Adaptation Gap Report, which proposed a **framework for defining adaptation gaps**, as well as a preliminary assessment of the gap between adaptation needs and reality. He explained that UNEP has been producing the Emissions Gap Report for several years, and that based on the request from Parties, UNEP carried out a preliminary analysis of a similar assessment for adaptation. He noted that **estimating the adaptation gap is far more challenging than calculating the emissions gap** because of the lack of a globally agreed goal or metrics for adaptation, and due to the fact that adaptation is a response to specific climate risks and impacts that are local in nature and vary over time.

103. He described a graph defining adaptation gaps (figure 74), which shows the difference between the present to medium-term impacts of climate change given present adaptation measures (or the business as usual

trajectory) and a trajectory with additional adaptation measures (or a societally desirable adaptation trajectory). He underlined that the gap is therefore the difference between what can be achieved with enhanced adaptation action and what society deems as the goal in terms of adaptation. He added that this societal goal is not zero because **society is ready to tolerate some amount of impact of climate change**, which is determined by local cost-benefit analyses, and some impacts are beyond our technical or physical ability to adapt.

104. On the **financial gap**, he pointed out that a major adaptation funding gap is likely, particularly after 2030, unless new and additional finance for adaptation becomes available. Many global estimates of this funding gap for developing countries exist. According to the World Bank, they range from USD 70 to 100 billion per year globally by 2050.[14] In 2014 Adaptation Gap Report, the authors assessed existing estimates global, sectoral and national estimates, which indicate that the costs of adaptation are likely, at a minimum, to be two to three times higher than World Bank estimates by the 2030s; and could be four to five times higher towards 2050 when results of global, regional, national and sectoral studies are aggregated. He stressed that adaptation costs grow very rapidly over time and are emission dependent. By 2050, adaptation costs could be **around twice as high in a 4 °C warming scenario than in a 2 °C warming scenario**, underlining that the best way to adapt to the impacts of climate change is to mitigate global warming (figure 75).

Figure 74
Defining the adaptation gap


Impact of climate change
Continuation of current level of adaptation effort
Adaptation achieved
Societally desirable adaptation
Technical and physical adaptation limits
Increasing adaptation effort
Impact reduction achieved
Potential for and limits to adaptation
Adaptation gap
Tolerated impacts
Technical and physical limits to adaptation
Present
Time
Medium-term

Source: Slide 3 of the presentation by Mr. Keith Alverson (United Nations Environment Programme), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_alverson.pdf>. The figure illustrates, in a schematic form, the concept of the adaptation gap used in the United Nations Environment Programme *Adaptation Gap Report*, which can be defined at the global or local level. The adaptation gap for any point in time is here the remaining difference between already implemented adaptation (dark green line at the bottom of the top grey area) and the potentially achievable adaptation as determined by technical and physical limits (yellow top of bottom dark area). The gap can then further be reduced by the tolerated impacts (difference between light lines in the middle).

105. Mr. Alverson underscored the difficulty of distinguishing between finance made available for adaptation and that for development or other purposes. Public finance committed to activities with explicit adaptation objectives ranged between USD 23 and USD 26 billion in 2012–2013, of which 90 per cent was invested in developing countries. He indicated that adaptation finance flows have increased in recent years across all sources of finance and are increasingly mainstreamed in development cooperation. He pointed out that only about two per cent of total adaptation finance came from multilateral mechanisms (USD 0.6 billion committed to developing countries in 2013), but noted an increasing trend.

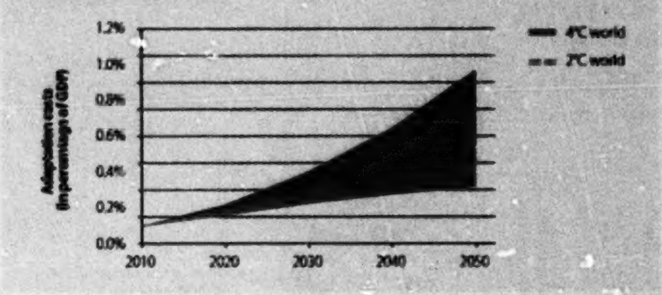
106. While stressing the **need to urgently scale up climate adaptation finance flows**, he underlined that: the Green Climate Fund (GCF) can play a central role in bridging the adaptation funding gap and its capitalization is close to reaching USD 10 billion; adaptation costs and finance needs are emission dependent and will rise more quickly under higher emission scenarios; risks and needs are not equally distributed, and least developed

---

[14] The World Bank. 2010. Economics of Adaptation to Climate Change - Synthesis Report. Available at <http://documents.worldbank.org/curated/en/2010/01/16436675/economics-adaptation-climate-change-synthesis-report>.

countries (LDCs) and small island developing States (SIDS) are likely to have much higher adaptation needs; and current analyses underestimate finance flows, as they do not include private sector and domestic spending.

Figure 75
Adaptation costs are emissions dependent



Source: Slide 5 of the presentation by Mr. Keith Alverson (United Nations Environment Programme), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_alverson.pdf>. The figure shows that by 2050, adaptation costs could be around twice as high in a 4 °C world scenario (solid green line and dark green area) than they are in a 2 °C scenario (dashed line, grey area). The areas show the likely (66 per cent) range of costs.
Abbreviation: GDP = Gross Domestic Product

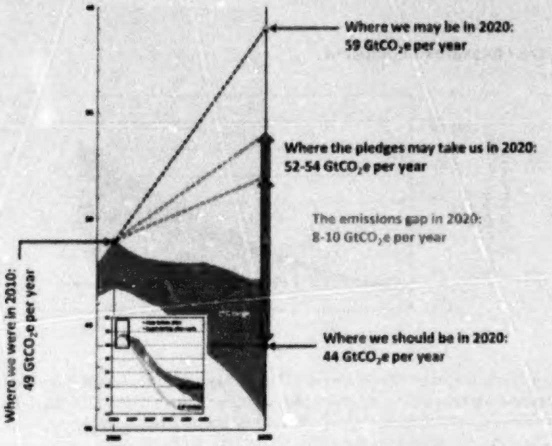
107. On the **technology gap**, estimates are largely drawn from the technology needs assessments communicated by Parties, as well as the technology made available through mechanisms such as the Climate Technology Centre and Network (CTCN) of the UNFCCC and others. Mr. Alverson underlined that the most appealing technology solutions are those that serve a variety of purposes above and beyond climate adaptation. There is a trade-off between the need to measure adaptation and the use of these integrated measures, which are more difficult to quantify than those solely targeting climate adaptation. He also underscored the importance of the acceleration of the diffusion of existing technologies and the role of research and development in adjusting existing technologies to local conditions. He identified scope for addressing gaps in knowledge production, knowledge integration, and knowledge transfer and uptake through a more efficient use of existing knowledge, systematic approaches and analysis, and improved monitoring and evaluation. To sum up, **there is significant potential to reduce the overall adaptation gap in the short and medium term through knowledge and technology**.

108. On the **knowledge gap**, he stated that a large portion of this gap is likely to be related to the transfer of knowledge. He referred to an article published in November 2014 in *Science*, which argues that **universal education is the key to adaptation**. The article points out that countries with the highest level of education are those that are best adapted to extreme climate events. In the *Adaptation Gap Report*, the authors have attempted to define a knowledge goal, particularly in assessing the effectiveness of adaptation action. He described the Adaptation Knowledge Initiative, carried out by UNEP, the UNFCCC Nairobi Work Programme and other partners, which aims to quantify and rank knowledge gaps regionally and by sector in an attempt to close the knowledge gap.

109. Mr. John Christensen (UNEP) presented on *The Emissions Gap Report 2014*. He explained that the origins of the report go back to COP 15 at which 141 Parties signed the Copenhagen Accord. Among the provisions of the Accord was a call to Parties to submit voluntary emission reduction pledges for 2020 and the setting of a temperature target. These two provisions raised the following question: **will pledges for 2020 be enough to meet the temperature target?**

110. UNEP published the first *Emissions Gap Report* ahead of COP 16 in late 2010. Many Parties to the Convention found this first edition useful and asked UNEP to update it annually, to inform negotiations on the level of ambition required from countries to meet the temperature target. The editions of the report provide an indication of: **what has been done in all these years; where emission trends seems to be taking us; where the full implementation of the pledges made after Copenhagen would take us; and where science modelling tells us we should be to reach the 2 °C limit.** He said the emissions gap is close to what was assessed in 2013, and that the gap has been almost constant for the past five years.

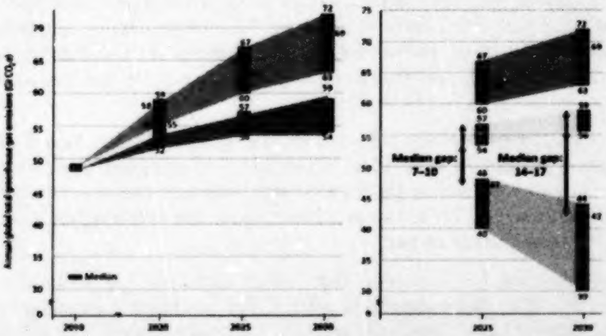
Figure 76
The emissions gap in 2020



Source: Slide 2 of the presentation by Mr. John Christensen (United Nations Environment Programme), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_christensen.pdf>. The figure shows that the emissions gap in 2020 remains at 8–10 Gt CO_2 eq per year as the difference between the Cancun pledges and emission pathways compatible with limiting warming below 2 °C above pre-industrial levels.
Abbreviation: $GtCO_2eq$ = Billion tonnes of CO_2 equivalent.

111. He explained that the top line indicates the 'business as usual' scenario at 59 Gt CO_2 eq, and the third line down illustrates emissions levels with the most stringent implementation of pledges, these are then compared to the median level of 44 Gt CO_2 eq for scenarios that meet the 2 degree target, which leaves a 8–10 Gt CO_2 eq gap in the year 2020 (figure 76). For this edition of the *Emissions Gap Report*, UNEP moved to a new set of models beyond 2020, looking at 2030 to inform the decision-making process. This is because the old models had a starting point for cost-efficient implementation in 2010, which did not happen. The new models therefore have a starting point of cost-efficient implementation in 2020, when the new climate agreement should apply. These new models imply steeper reductions of GHGs after 2020, higher mitigation costs, negative emissions and significantly higher climate risks.

Figure 77
The emissions gap in 2025 and 2030

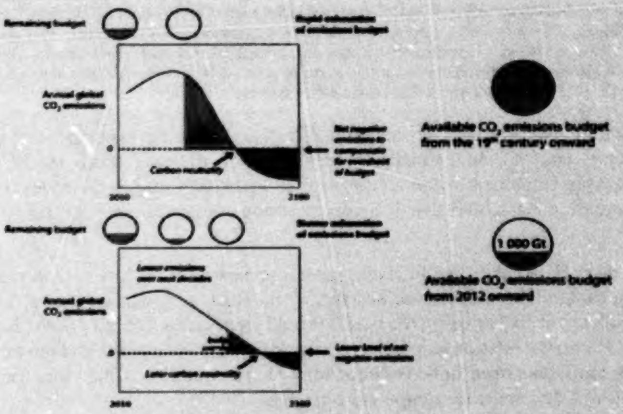


Source: Slide 4 of the presentation by Mr. John Christensen (United Nations Environment Programme), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_christensen.pdf >. The figure shows that the emissions gap in 2025 is 7–10 Gt CO_2 eq, and in 2030, the gap is significantly bigger, at 14–17 Gt CO_2 eq.
Abbreviation – $GtCO_2eq$: Billion tonnes of CO_2 equivalent.

112. Mr. Christensen indicated that since climate change negotiations are increasingly focusing on 2030, the 2014 edition of the *Emissions Gap Report* provides estimates of the gap in 2025 and 2030 (figure 77). To do so, UNEP calculated emission growth rates in the period 2020–2030 in four sectors: energy; non-CO_2 GHG emissions; CO_2 emissions from industry; and emissions from land-use change. He added that for the energy sector, UNEP used IEA data, and for the other three sectors UNEP used data from the IPCC scenario database. By combining these growth rates with the share of global emissions of each of the sectors above, UNEP extrapolated to 2030 the low- and high-end of the four pledge cases in 2020. By interpolation, UNEP obtained an estimate for 2025. **The emissions gap in 2025 is 7–10 Gt CO_2 eq, and in 2030 the gap is significantly bigger, at 14–17 Gt CO_2 eq.**

113. He pointed to the focus in this year's edition on targets for 2030, and the emission budget for staying within the 2 °C limit, and referred to the discussions held during part 1 of SED 4-1 on the carbon budget, which corresponds to the total amount of carbon emissions that can be emitted while still staying within that limit.

Figure 78
The remaining carbon budget


Remaining budget
Annual global CO2 emissions
0
Carbon neutrality
Available CO2 emissions budget from the 19th century onward
Remaining budget
1 000 Gt
Available CO2 emissions budget from 2012 onward
Annual global CO2 emissions
0
Later carbon neutrality

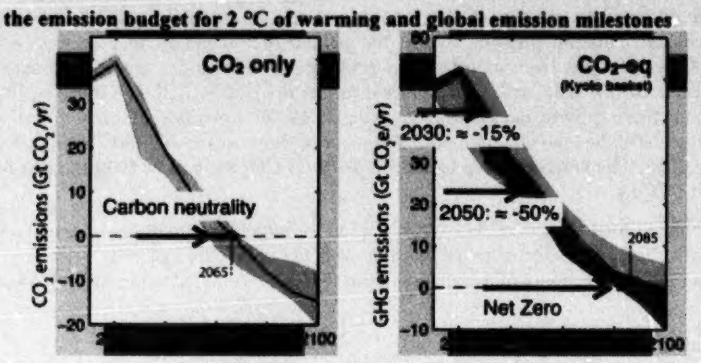
Source: Slide 5 of the presentation by Mr. John Christensen (United Nations Environmental Programme), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_christensen.pdf >. The figure illustrates the differences between early (bottom) and delayed action (top) in terms of the pathway of global emissions for remaining under 2 °C of warming relative to pre-industrial levels.

Abbreviation: Gt = a billion tonnes

114. He explained that at present, we have about 1,000 $GtCO_2eq$ available in our budget, down from 2,900 at the beginning of the industrial revolution (figure 78). If we focus on CO_2 **only, emissions need to decrease to net zero between 2055 and 2070 to stay within the 2 °C limit** (figure 79). Meanwhile, all GHGs emissions need to decrease to net zero between 2080 and 2100 to stay within the 2 °C limit. He stressed that the longer we wait on getting the curve bent, the steeper the curve, even with negative emissions towards the end of the century. He added that carbon neutrality and, in many cases, negative emissions will have to be reached, implying that carbon will have to be totally taken out of the system, through large deployment of biomass energy with CCS, or massive scale tree planting, stressing that the ensuing land, water and population requirements will be very challenging.

Figure 79

How to spend the emission budget for 2 °C of warming and global emission milestones



Source: Slide 5 of the presentation by Mr. John Christensen (United Nations Environment Programme), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_christensen.pdf>. The figure identifies the period 2055–2070 as the net zero CO_2 emissions window, and 2080–2100 as the net zero emissions window for total greenhouse gas emissions for emission pathways compatible with limiting warming below 2 °C above pre-industrial levels.

Abbreviation: Gt CO_2 eq = Billion tonnes of CO_2 equivalent emissions.

115. In concluding, Mr. Christensen underlined that a qualitative assessment of the mitigation potential of various key sectors and of country pledges shows that, on average, about 10–30 per cent of the mitigation potential identified is contained in the actual pledges, pointing to the large room for increasing ambition. On energy efficiency, he underscored that it involves various actors and a wide range of wins, and "hardly any loses".

116. Mr. Stéphane Hallegatte (World Bank) gave a presentation on low-carbon resilient development, with a focus on pricing carbon. He underscored that the World Bank sees climate change as a development challenge that no 'silver bullet' can fix, stressing the need for policy packages. On mitigation, he noted the robust scientific findings in the AR5 on the relationship between cumulative CO_2 emissions and temperature. To stabilize climate change, **net CO_2 emissions need to be reduced to zero**. The question is therefore the speed at which this goal is achieved, since it will determine the temperature change.

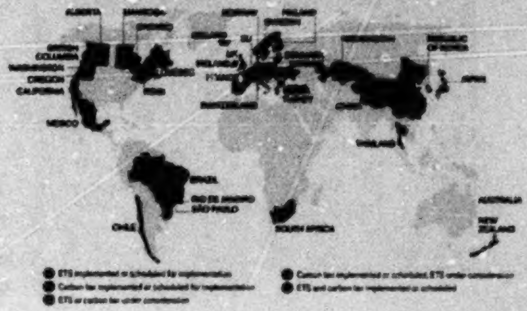
117. He identified four elements common to all models that provide the emission reductions required to bring emissions to zero at the end of the century, regardless of the temperature target, namely the need to: **improve energy efficiency**, with better buildings, cars, light, appliance, etc.; **carry out a fuel shift in most economic activities**, including transport, heating and industries; **decarbonize electricity generation**; and **implement land-use changes** in forestry, agriculture and urban development. He stressed that these four elements require immediate actions in different sectors.

118. Noting that "we know what needs to be done", he described the support provided by the World Bank for countries to: reform fossil fuel subsidies and carbon pricing; improve energy efficiency; enhance renewable energy uptake and diversify their economy; double the rate of improvement of energy intensity by 2030, as called for by the SE4ALL initiative; carry out land-use planning, city planning and financing; and finance public transit.

119. **On fossil fuel subsidies and carbon pricing**, he referred to the United Nations Climate Summit held in September 2014, where 73 countries and over 1,000 investors and firms **called for carbon pricing** as a tool to ensure that climate change is mitigated in an efficient manner, underlining the importance of complementary social measures to ensure that the reform is not damaging poverty reduction. He also pointed to the Bank's goal of stopping illegal deforestation by 2030 and making 100 per cent of the World Bank Group's agriculture projects climate-smart by 2018. **On carbon pricing**, Mr. Hallegatte mentioned the *State and Trends of Carbon Pricing 2014*, which indicates that it is gaining momentum, highlighting its **large co-benefits in terms of**

development and well-being[15] (see figure 80). He also referred to *Climate-smart Development*, which looks at the co-benefits that climate policy can bring, emphasizing that reduced air pollution and health-related deaths are some of the largest co-benefits of climate change mitigation.[16]

Figure 80
Carbon pricing is gaining momentum



Source: Slide 9 of the presentation by Mr. Stéphane Hallegatte (World Bank), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_hallegatte.pdf>. The figure shows the world map highlighting countries where various schemes for carbon pricing have been implemented or are scheduled.
Abbreviation: ETS = emissions trading scheme.

120. **On adaptation and resilience**, he cautioned that even if the target is 1.5 °C or 2 °C, it would be too risky to assume that it will be reached when planning for adaptation, pointing to the critical example of climate sensitivity uncertainty. The World Bank therefore plans adaptation with more pessimistic scenarios. Mr. Hallegatte explained that the series of three reports titled *Turn Down the Heat* investigates how impacts vary when warming increases from 2 °C to 4 °C above pre-industrial levels, and finds that "the difference is huge" (figure 81).[17] For example, in a world **2 °C warmer, water availability is projected to be reduced by 20 per cent, while this would go up to 50 per cent in a world 4 °C warmer**. The same **non-linearity exists for projected heat extremes, or the bleaching of coral reefs, with close to double impacts in a world 4 °C warmer compared with 2 °C warmer than in pre-industrial times, implying very different adaptation needs**. In the light of uncertainty about temperature change in the future, adaptation planning needs to take into account the possibility of global warming of 4 °C or higher.

121. **On climate change and poverty**, he stressed that the poor are often more exposed and more vulnerable to extreme weather events. He pointed to the example of the city of Mumbai in India, where the lowest quintile is disproportionally represented in the flood zone, and the richest quintile is almost absent. He added that when households are affected, as was the case in 2005, they can lose all their savings and approximately a year of income, representing significant obstacles to saving and accumulating the assets needed to escape poverty.

122. He stressed the dynamics of poverty, using the example of Andhra Pradesh in India, where the flows out of poverty are 14 per cent per year, but where 12 per cent of households fall back into poverty every year. The flows out of poverty are therefore small compared with annual flows in and out of poverty. He warned that: relatively minor impacts on these flows in and out of poverty can have a large impact on net poverty reduction; weather events are already a major cause for people to fall into poverty and constitute major obstacles for people

---

[15] World Bank Group. 2014. State and Trends of Carbon Pricing 2014, May 2014. Available at <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0Carbo040Box385232B00OUO090.pdf>.

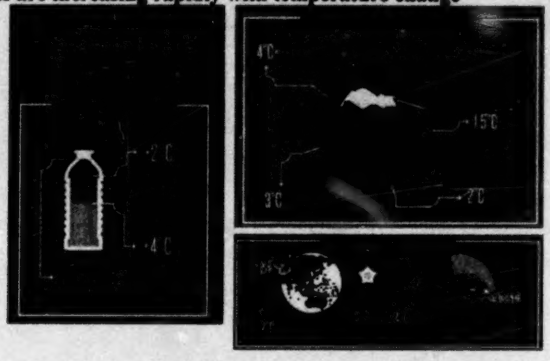
[16] Climate Works Foundation and World Bank Group. 2014. Climate-smart Development. Available at <https://openknowledge.worldbank.org/bitstream/handle/10986/18815/889080WP0v10RE0Smart0Development0Ma.pdf?sequence=1>.

[17] World Bank. Turn Down the Heat. Available at <http://www.worldbank.org/en/topic/climatechange/publication/turn-down-the-heat>.

to escape poverty; and in the absence of strong action, climate change will magnify these effects, potentially creating a significant drag on poverty reduction and a threat to sustained poverty eradication.

Figure 81

Climate change impacts are increasing rapidly with temperature change



Source: Slide 13 of the presentation by Mr. Stéphane Hallegatte (World Bank), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_hallegatte.pdf>. The figure indicates the non-linear relationship between temperature increase and adaptation needs, and that adaptation needs for a 4 °C warmer world scenario and a 2 °C scenario are very different.

123. On the International Development Association (IDA), the World Bank's fund for low-income countries, he highlighted commitments to better mainstream climate and resilience into development, and to screen all IDA projects for climate and disaster risks, pointing to ongoing work on developing and improving tools to do so.

124. In concluding, he underscored the importance of considering climate policies, related to both adaptation and mitigation, as development issues.

125. Ms. Christina Hood (IEA) gave a presentation on the challenges and opportunities related to energy and climate change, describing: the current state of the energy sector; modelling results and five key actions to achieve a low-carbon energy sector; and issues related to technology risk and risk management.

126. To describe the current state of the energy sector, she listed relevant IEA resources: energy and CO_2 statistics;[18] free online database; smartphone apps; energy efficiency indicators; the *Energy Efficiency Indicators: Fundamentals on Statistics*[19]; energy technology, and research and development indicators; medium-term market reports; the *World Energy Outlook*[20] and *Energy Technology Perspectives*[21] scenario analysis; and policy studies.

127. Besides emission levels, she said that another key aspect of the transition towards a low-carbon economy is the development of the needed technologies. In the *Tracking Clean Energy Progress Report 2014*,[22] the IEA compares how quickly key clean energy technologies are being developed and deployed compared to interim 2025 targets in the *IEA 2014 Energy Technology Perspectives* 2 °C scenario, which lays out pathways to a sustainable energy system in 2050.

---

[18] See IEA statistics web page, available at <http://www.iea.org/statistics/>; and CO2 statistics. Available at <http://www.iea.org/statistics/topics/co2emissions/>.

[19] IEA. 2014. Energy Efficiency Indicators: Fundamentals on Statistics. Available at <http://www.iea.org/publications/freepublications/publication/energy-efficiency-indicators-fundamentals-on-statistics---.html>.

[20] IEA. 2014. World Energy Outlook 2014. Available at <http://www.worldenergyoutlook.org/publications/weo-2014/>.

[21] IEA. 2014. Energy Technology Perspectives 2014. Available at <http://www.iea.org/bookshop/472-Energy_Technology_Perspectives_2014>.

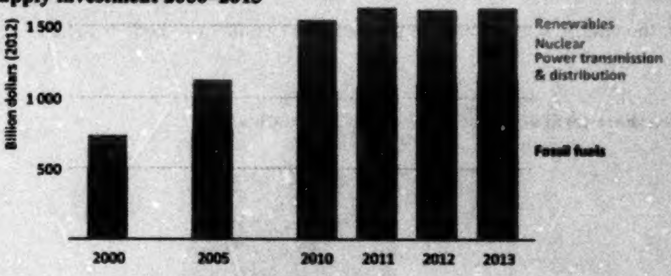
[22] IEA. 2014. Tracking Clean Energy Progress Report 2014. Available at <http://www.iea.org/publications/freepublications/publication/Tracking_clean_energy_progress_2014.pdf>.

128. Ms. Hood underlined that this assessment indicates that technology development is off track for levels consistent with a 2 °C scenario, except for renewable power generation. She explained that **"we are not on track" not only in relation to turning the tide of coal, but across the entire energy system**. She warned against the costs of delaying action to transform our energy system. The **only exception – renewables - is not enough to meet long-term sustainable energy goals.** She stressed that a broad range of technologies are needed across all production, generation and end-use sectors – especially in the electricity sector. Ms. Hood cautioned that without progress in the development, demonstration and deployment of these technologies, it will not be possible to meet long-term climate, security and economic goals for energy systems, calling on policy-makers to "change this picture".

129. On investments, Ms. Hood underscored that investment in energy supply has doubled since 2000 and investment in renewables has scaled up considerably, but fossil fuels still dominate energy supply investments (figure 82).

Figure 82

Annual energy supply investment 2000–2013



Source: Slide 6 of the presentation by Ms. Christina Hood (International Energy Agency), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_hood.pdf>. The figure shows that fossil fuels still dominate annual energy supply investments.

130. On the ownership of worldwide power generation capacity and oil and gas reserves, she noted that a large proportion is held by state-owned companies. As a result, alongside investment by the private sector, the objectives, corporate culture and financing of state-owned companies will be critical to future energy investment flows.

131. On the key results of the IEA long-term models, she explained that from the *World Energy Outlook* and *Technology Perspectives*, the IEA extracted **six key measures** to achieve the 2 °C pathway (see figure 28).

132. **First**, action should start immediately, both to keep the emission pathway within reach and to limit the emission overshoot, but also to **implement some cost-effective short-term action** that can stop the growth in emissions by 2020 at no net economic cost, reducing emissions by 3.1 Gt, and carrying out 80 per cent of the savings required for a 2 °C pathway (figure 83). These measures include: implementing selected energy efficiency policies; limiting the use of inefficient coal power plants; reducing CH_4 releases from upstream oil and gas; and partially removing fossil-fuel subsidies.[23] She stressed that these measures are GDP-neutral in every region in the IEA model. She explained that renewable energy is not mentioned in the figure because it is already in the baseline scenario of the model.

133. **Second**, the **electricity sector should be decarbonized.** She compared a 6 °C scenario – if current policies remain in place – to the 2 °C scenario, where a dramatic change in the power sector takes place, with 94 per cent of electricity generated from low-carbon sources (renewables, nuclear, CCS) in 2050, and which will require focused attention from policy-makers.

---

[23] IEA. 2013. World Energy Outlook Special Report: Redrawing the Energy-Climate Map. Available at <http://www.iea.org/publications/freepublications/publication/weo-special-report-2013-redrawing-the-energy-climate-map.html>.

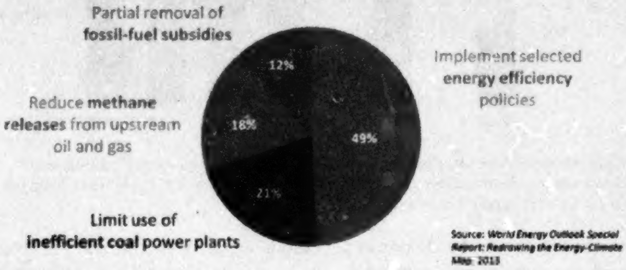
134. **Third, investment patterns need to be reshaped**, especially for long-lived infrastructure. She compared the 450 ppm scenario to a new policies scenario, where efficiency spending is USD 6 trillion higher and the composition of supply investment changes, with the wide deployment of CCS and USD 300 billion of fossil fuel investment left stranded. In both scenarios, the total quantity of investment does not change much in energy supply, but there is a large shift from fossil fuels to low-carbon technologies. In addition, there is a scaling-up in investments of a factor of about four compared with current levels in energy efficiency and clean energy supply.

135. **Fourth, innovation in key technologies needs to be accelerated**, both in the short and in the long-term. In the short-term, renewables and energy efficiency are key in delivering emission savings. In the longer term, investments should be made now to ensure that technologies related to CCS and end-use fuel switching, including the electrification of transport, will be available when they are needed.

136. **Fifth, non-climate drivers of actions that reduce emissions should be harnessed.** She stated that in many cases, these non-climate drivers are the real reasons why governments take action. She called on the UNFCCC process to harness these other objectives, such as economic development, air quality improvement, energy security or road congestion alleviation, in order to maximize action on the ground.

137. **Sixth, the energy sector needs to become more resilient** to both extreme events and long-term gradual changes.

Figure 83
Cost-effective short-term action to achieve the 2 °C pathway



Source: Slide 9 of the presentation by Ms. Christina Hood (International Energy Agency), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_hood.pdf>. The figure shows that four measures can stop the growth in emissions by 2020 at no net economic cost.

138. Ms. Hood then addressed **managing technology risks**, underlining that technology delay will increase the costs and reduce the feasibility of low-carbon scenarios. To ensure that technologies needed for the transition to a low-carbon economy are available and at scale, she stressed the need for: international collaboration to share best-practice policy frameworks for research, development and demonstration (RD&D) support and evaluation; a portfolio approach to RD&D; the tracking and reporting of the global level of investment in technology development; a strong focus on energy efficiency; and economy-wide broad-based policies for implementation.

139. In concluding, she noted that **current policies and investment patterns are not consistent with a 2 °C scenario,** but that **moving to a 2 °C pathway is technically possible and affordable, but requires sustained efforts.** To achieve this pathway, she outlined key actions, namely: act to reduce emissions pre-2020; focus on the decarbonization of the power sector; shift investment patterns; accelerate clean energy technology development; harness non-climate objectives; build resilience; and mitigate the risks of technology delay.

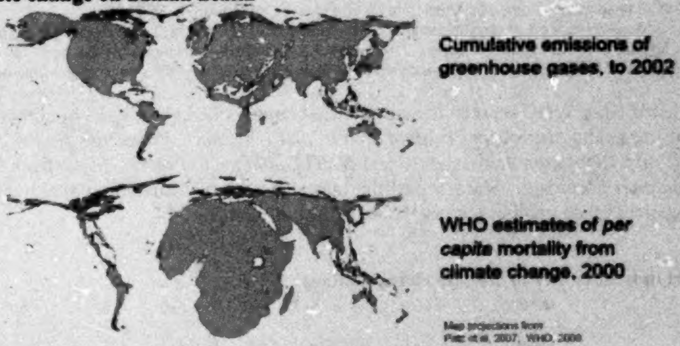
140. Ms. Kristie Ebi (WHO) gave a presentation on the health impacts of climate change. She stated that for the health community, there is no 'safe limit' for climate change and current climate risks are already unacceptable, underlining the importance of urgent adaptation and mitigation action. For WHO, the definition of 'tolerated impacts' is different to that used in the UNEP *Adaptation Gap Report*. There is a wide range of health outcomes that cause significant morbidity and mortality around the world today, many of which are sensitive to weather and climate. A small proportion of deaths from climate-sensitive health outcomes are currently due to climate change, indicating that **people are already suffering and dying from climate change**, which, from the perspective of the health sector, is intolerable.

141. She presented two world maps representing the cumulative emissions of GHGs to 2002, and the WHO estimates of per capita mortality from climate change in 2000, highlighting the extremely uneven distribution of emissions and impacts (figure 84).

142. Ms. Ebi pointed to the example of the heat wave in the Russian Federation in 2010, which lead to fires, heavy air pollution and about 11,000 excess deaths. It is estimated, with an 80 per cent level of confidence that the 2010 Moscow heat wave (and associated deaths) was due to climate change.

143. She then presented a graph from the human health chapter of the WGII contribution to the AR5, which illustrates the health impacts of climate change and the potential for adaptation (figure 85). The graph also shows the challenges that will have to be faced and what the residual risks could be. For each section of the pie, the orange indicates the risk levels with current levels of adaptation, while the yellow sections indicate the risks after high levels of adaptation. She underlined that this figure is based on the literature assessed in the AR5 and on expert judgment. Unfortunately, the efforts required to achieve high levels of adaptation are not consistent with current levels of funding for adaptation or technology transfer. In comparison with the current levels of risk, 1.5 °C of warming is projected to lead to very large increases in health risks, both in what can be avoided and what will remain. In a world 4 °C warmer, the risks are very high.

Figure 84
Impacts of climate change on human health


Cumulative emissions of greenhouse gases, to 2002
WHO estimates of *per capita* mortality from climate change, 2000
Map projections from
Patz et al, 2007; WHO, 2008

Source: Slide 3 of the presentation by Ms. Kristie Ebi (World Health Organization), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_ebi.pdf>. The figure shows the origin of cumulative emissions per continent and/or region by altering the relative size of the area (upper map, shrunken area means below average, enlarged area above average emissions) and similarly the estimates of per capita mortality (bottom map).

144. As another example, she referred to the ability of people to work in very high temperatures. She explained that full working capacity declines as temperature increases. According to the AR5, in Southeast Asia, in 2050, more than half of the afternoon work hours may be lost due to the need for rest breaks. According to a paper by Sherwood and Huber in the *Proceedings of the National Academy of Sciences*, a 10 °C of warming, large populated areas of the global would be in many respects uninhabitable.[24]

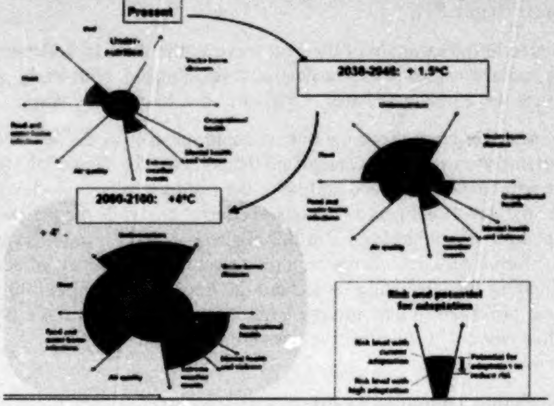
145. Ms. Ebi then presented WHO estimates from fall 2014 of **mortality due to climate change: approximately 150,000 excess deaths per year at present, and approximately 250,000 in 2030**. She noted that these are only estimates of the four health outcomes for which there was sufficient information to run a model, not all possible health outcomes (figure 86).

---

[24] Proceedings of the National Academy of Sciences. 2010. Available at <http://www.pnas.org/content/by/year/2010>.

Figure 85

Near-term and long-term risks in the health sector and potential for adaptation

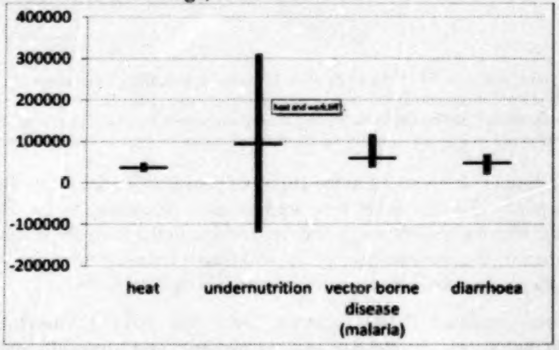


Source: Slide 5 of the presentation by Ms. Kristie Ebi (World Health Organization), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_ebi.pdf>. The figure shows various health risks for humans as posed by climate change at present, at 1.5 °C and at 4 °C of warming above pre-industrial levels, as well as the potential for adaptation (dark orange areas; light orange areas represent the remaining risks under high adaptation).

146. She listed other WHO reports that aim to help countries facing the risks of climate change to improve the resilience of the health sector: the *Atlas of Health and Climate*;[25] *Protecting Health from Climate Change – Vulnerability and Adaptation Assessment*;[26] and *WHO Guidance to Protect Health from Climate Change through Health Adaptation Planning*.[27] She stressed the importance of mainstreaming health concerns in other sectors, noting that choices made in other sectors should be health-resilient.

Figure 86

Estimates of mortality due to climate change, 2030s



Source: Slide 7 of the presentation by Ms. Kristie Ebi (World Health Organization), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_ebi.pdf>. The figure shows the estimates of excess mortality due to heat, under-nutrition, vector-borne disease, and diarrhoea, caused by climate change in the 2030s assuming the SRES A1B scenario and 50 per cent adaptation.

---

[25] World Health Organization. 2012. Atlas of Health and Climate. Available at <http://www.who.int/globalchange/publications/atlas/en/>.

[26] World Health Organization. 2011. Protecting Health from Climate Change – Vulnerability and Adaptation Assessment. Available at <http://www.who.int/globalchange/publications/Final_Climate_Change.pdf>.

[27] World Health Organization. 2013. WHO Guidance to Protect Health from Climate Change through Health Adaptation Planning. Available at <http://apps.who.int/iris/bitstream/10665/137383/1/9789241508001_eng.pdf?ua=1>.

147. In concluding, she underlined that: there is no 'safe limit' for health, as climate variability and change are already impacting health significantly and inequitably; higher rates of warming are projected to further increase health risks; various thresholds exist at individual and community levels but are not linked to specific rates of global warming; much, but not all, of the current and future burden could be avoided through proactive and efficient adaptation; and mitigation is critical to reduce future health threats, as a precaution against uncertain risks and to gain large health co-benefits.

148. Mr. Alexandre Meybeck (FAO) gave a presentation on agriculture, food security and climate change. He described the triple challenge of: producing more food, in quantity, quality and diversity, everywhere for everyone; adapting to climate change; and contributing to climate change mitigation. He underscored that the **world's population will increase by one third by 2050, thereby increasing food demands,** and stressed that in some areas, population will double or triple, and that often these are areas that are the most food insecure and vulnerable to climate change. Mr. Meybeck indicated that FAO estimates that **global agricultural production will have to increase by 60 per cent by 2050** to satisfy the increase in demand driven by population growth and diet changes.

149. With regards to adaptation, he stressed that there are **huge gaps in knowledge about the impacts of climate change on a lot of crops and on agro ecosystems**, such as pollinators. These gaps in knowledge exist for all the interrelations in the soil or on the farm that enable farmers to produce food. **There is no safe limit to the increase in emissions because of the uncertainties about the impact of climate change on these complex ecosystems.** Another area where there are significant gaps in knowledge is crop and animal diseases, which are impacted by climate change. In short, we do not have enough information about the impacts of climate change on biophysical ecosystems. This information gap is even more significant in relation to food systems, which combine biophysical and socioeconomic systems.

150. What is certain is that with climate change, there will be a decrease of production in certain areas, changes in the geography of production, and an increased variability of production. All of these will have an impact on all the dimensions of food security and nutrition, with stronger impacts on the most vulnerable countries and the most vulnerable people, including small holders. There is less knowledge on the impacts of nutrition, because most of the research has been carried out on staple crops.

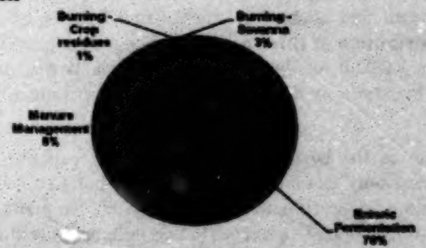
151. With regards to mitigation, agriculture can **reduce emissions per kilogram of output** – or decouple production and emission growth, and enhance agricultural soil carbons sinks.

152. He explained that FAO combines the three objectives of producing more food, adapting to climate change and contributing to climate change mitigation, through **climate-smart agriculture** (CSA), which focuses on more resource-efficient and resilient ecosystems. Resilience needs to be viewed at different scales from both a socioeconomic and an environmental and ecosystem perspective.

153. He said a large part of the mitigation potential of agriculture is in land use, which implies decreasing deforestation, sustainably increasing the production on degraded lands and decreasing emissions from livestock. On livestock, he underlined that **agriculture accounts for 50 per cent of global CH_4 emissions, and within agriculture 78 per cent of CH_4 emissions are from livestock** (figure 87).

Figure 87

Methane emissions from livestock



Source: Slide 16 of the presentation by Mr. Alexandre Meybeck (Food and Agriculture Organization of the United Nations), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_meybeck.pdf>. The figure shows that 78 per cent of methane emissions are from livestock.

154. **CH_4 emissions are also energy losses**, so reducing methane emissions results from improved natural resources use efficiency. He stated that a wide range of technical interventions can improve natural resource use efficiency and productivity while reducing emissions, including: using grazing in place of feed, improvements in the management of the herd, better genetics, better feeding programmes and better veterinary services. There are **non-climate drivers** of action and these are those we need to mobilize if we want to incentivize farmers to take action.

155. This focus on livestock shows opportunities for high impact: livestock represents 78 per cent of agricultural and 40 per cent of global CH_4 emissions; livestock production is expected to grow; the reduction in emissions from livestock comes at low cost and with a wide range of co-benefits (climate, productivity, profitability, food security, nutrition, human health, green energy, etc.); and technologies are available and provide cost-effective reduction opportunities, especially for low productive systems, using relatively common practices, although a number of barriers need to be overcome.

156. He used the example of a project in Zambia to illustrate that the margin for reducing emissions in the agricultural sector without threatening food production and food security is limited. In concluding, he emphasized that the key is to increase natural resource efficiency while being able to resist the impact of climate change. Globally, the more efficient a breed, the more sensitive it is to any variations, especially to heat waves.

2. General discussions

157. The ensuing discussion was guided by the following questions:

(a) We heard from the IPCC that increasing magnitudes of warming will increase severe, widespread and irreversible impacts of climate change. In the light of this, what are the risks assessed by your organization on human health, food production and other ecosystem services at a 1.5–2.0 °C level of global mean warming compared with pre-industrial levels, and how does your organization contribute to reducing and managing these risks?

(b) What is the gap between current mitigation and adaptation efforts and those required to achieve the long-term global goal as characterized by a 1.5–2.0 °C level of warming relative to pre-industrial levels? How can this gap be bridged?

(c) What policy options has your organization identified for the decarbonization of the energy system called for by pathways consistent with limiting warming below 1.5 °C or 2 °C compared with pre-industrial levels? What are the economic and technological risks associated with this decarbonization?

(d) How effective have the steps taken by your organization been in terms of supporting national activities aimed at minimizing the impacts of climate change? What barriers have your organization encountered and how has it succeeded in overcoming them?

(e) Which policies and measures has your organization identified as effective to bridge the emissions and adaptation gap, and how can these policies and measures be emulated?

158. Noting that the *Adaptation Gap Report* presented the adaptation costs for scenario RCP2.6, which projects the lowest median global warming of all the RCP scenarios (approximately 1.6 °C by 2100), one Party asked about the **adaptation cost implications of an additional 0.5 °C of warming**. She also asked for more information on the estimate that adaptation costs would be 3–4 or 4–5 higher than previous World Bank estimates, and on the **distribution of these costs**, especially in relation to SIDS and LDCs. An expert explained that UNEP used scenario RCP2.6 for the 2 °C limit, so actually the lower cost estimate corresponds to 1.5 °C than 2 °C of warming, but the cost ranges for the two temperature limits overlap significantly in the early decades.

159. On the **differences in the cost estimates**, one expert explained that this stems from the fact that the *Adaptation Gap Report* not only examined global studies, but also sectoral and national studies, and that the latter contain huge variations in the climate scenarios applied, the methods used and assumptions made, and the temporal, spatial and sectoral scope of coverage. In addition, national studies have more realistic assumptions on barriers to implementation of adaptation, which tend to raise the costs significantly. Another expert added that higher estimates of adaptation costs are due to the fact that the coverage of previous estimates was limited in terms of sectors, whereas in the *Adaptation Gap Report*, the authors assessed more sectors and more countries;

the World Bank estimates were based on a 2 °C pathway, whereas a 4 °C pathway raises significantly the costs of adaptation, and the national-level studies examined do not always distinguish between the 2 °C and 4 °C scenarios; and in previous assessments, the gains and losses from adaptation were aggregated, potentially lowering the costs of adaptation, but in the *Adaptation Gap Report* this was corrected to be more precise, as often gains and costs are often not comparable between sectors. Yet another expert underscored that some of the vulnerability is linked to the lack of infrastructure, and that the World Bank estimates that infrastructure lacks USD 1–1.5 trillion per year.

160. On the **regional distribution of adaptation costs**, an expert emphasized that when there is an existing development and adaptation deficit, future adaptation costs are projected to be much higher, as is the case in SIDS and LDCs, although no specific estimates for SIDS or LDCs are currently available.

161. One Party asked for confirmation that the *Emissions Gap Report* assesses relevant literature on scenarios that return warming to below 1.5 °C above pre-industrial levels by 2100, and that there are technologically and economically feasible scenarios available in the literature that achieve this limit. She asked if **the same methodology as was used in the scenario analysis of the *Emissions Gap Report* to provide emission benchmarks for 2025 and 2030 could be applied to these 1.5 °C scenarios**. An expert clarified that for the *Emissions Gap Report*, UNEP focused on 2 °C of warming as the main area for analysis, but that there has also been work on the 1.5 °C scenario. Another expert confirmed that, for the 2014 edition of the *Emissions Gap Report*, UNEP used the AR5 scenarios database for their quantitative assessment, and that these scenarios are deemed technologically and economically feasible. He added that, in the literature, there are studies available that produce the same kind of scenarios but limit temperature increase to 1.5 °C above pre-industrial levels by 2100. The latter scenarios were not contributed to the AR5 database. An assessment of these scenarios was taken into account in the 2014 *Emissions Gap Report* and previous editions, but not in the same way as for 2 °C scenarios. He said that **in principle, the same methodology could be applied to the smaller set of 1.5 °C scenarios**, with some caveats: these scenarios all include a **temperature overshoot**; they achieve the target with **approximately 50 per cent probability**; and the scientific basis will be weaker because of the limited amount of 1.5 °C scenarios. In response to this question, an expert provided emission benchmarks for 1.5 °C scenarios based on the *Emissions Gap Methodology* to the SED co-chairs.

162. In response to a question by one Party about **which technologies are the most promising** for achieving negative emissions, an expert indicated that these are predominantly the **sustainable production of bioenergy**, CCS and **increased forest cover**. He underlined that UNEP did not assess these options, but noted the need to assess the feasibility of the assumption that these technologies will be available at scale when needed. Another expert explained that WGIII explored the consequences of the unavailability or the limited availability of these technologies. He stressed that **CO_2 removal technologies are essential in achieving negative emissions**, which serve two purposes: they are necessary because of historic emissions; and more importantly, in the second half of the century, they will **compensate for those non-CO_2 gas emissions that cannot be reduced to zero**. WGIII explored a comprehensive range of technologies and the consequences of the unavailability of CO_2 removal technologies, which would mean that emissions should be more significantly reduced in the short-term in order to achieve a relatively cost-effective pathway. Another expert explained that the IEA scenarios would fall within the lower end of those included in the *Emissions Gap Report*, with rapid reductions in the short-term, because IEA experts are uncomfortable with assuming massive reductions with negative emissions later in the century. However, she noted that IEA scenarios cover the period up to 2040 or 2050, by when CRD technologies will not have been introduced yet, but the design of the scenario makes assumptions about what will happen beyond these dates. On prospects for the CDR technology, she said it is a question of combining bioenergy and CCS, noting that at present, very slow progress has been made with CCS itself, let alone coupling it with bioenergy. She therefore underscored the **need for significant progress on CCS**.

163. A Party asked about the meaning of the term **'societally desirable adaptation'** in the *Adaptation Gap Report*, since adaptation is often not a choice. An expert explained that the term is based on the WGII report, which describes how to move from a level of adaptation that is technically and economically feasible, to what will actually happen on the ground. She noted that some communities or groups may choose to tolerate a higher level of climate change impacts because of different preferences regarding the adaptation target.

164. A Party asked if the figure of 90 per cent of adaptation funding going to developing countries mentioned by one of the presenters includes national and regional funds, as well as private sectors funds, at the national level. An expert clarified that the figure comes from a study of the Climate Policy Initiative, and includes

developed and developing countries' funding for adaptation, including that from national and regional development banks.[28]

165. A Party asked about the **cumulative impacts of the pledges made at the September 2014 United Nations Climate Summit** in relation to mitigation and adaptation. An expert stated that the United Nations office in charge of the summit is trying to set up a tracking system of the many pledges made, while noting the challenges of doing so because the pledges are often not concrete commitments and are not comparable, and their additionality is difficult to assess. Another expert added that the summit should be seen within a process that aims to build momentum on the road to Paris, and that assessing individual steps separately may not give an accurate picture, as follow up action may be taken in the future.

166. A Party asked a question concerning WHO figures that indicate that with 1.5 °C warming, the **number of children at risk of stunting will increase by more than 6 million by 2030** even with high economic growth. In response, an expert confirmed that this can be considered conservative since it does not take into account climate-related disasters and their potential impects on food production and prices, implying that the projected increase in stunting is conservative.[29] The expert further clarified that the WHO looked at each health outcome at a time so the total aggregate impacts were not estimated.

167. A Party asked about the long-term **physical limits of the potential for negative emissions**. He queried whether relying heavily on negative emissions during this century could lead the sinks to be "entirely filled up", thereby prejudicing future generations after 2100. An expert said he did not know the answer but that he would look it up and provide the required information by the next day. Another expert explained that to determine the physical limits to negative emissions, one needs to take into account the fact that the oceans will lose part of the previously absorbed CO_2. Experts provided further information indicating that, to date, there are only rough estimates of the total global storage capacity. Estimates indicate that the capacity is significantly larger than storage needs in low GHG level stabilization scenarios up to 2100. Geological reservoirs could store several thousand GtC, the oceans a few thousand GtC in the long term, and the land may have the potential to store the equivalent to historical land-use loss of 180 ± 80 GtC (see also WGI Table 6.15, page 549 for physical potentials of removing CO_2 from the atmosphere).

168. Noting that by the end of 2100, non-CO_2 gases will have a larger share of global emissions, a large portion of which will come from agriculture to meet the demands of a growing population, a Party asked whether strategies exist to **combine the need for agriculture to adapt to climate change and to reduce its emissions**. An expert clarified that all scenarios that predict a lower global level of emissions feature a larger share of agricultural emissions and an important share of non-CO_2 emissions, which is why to achieve zero net emissions, negative emissions have to be factored in, because "we do not know how to produce food without emitting". FAO aims to achieve the three objectives of producing more food, adapting to climate change and contributing to climate change mitigation through CSA.

169. A Party asked for an indication of **which of the results presented** during part 2 of SED 4-1 **come from the AR5, and which do not**. An expert indicated that the WHO estimates were published after the IPCC cut-off dates and were therefore not part of the assessment, although the IPCC authors were aware of the work being done.

170. A Party asked **how the adaptation gap is going to be addressed**, adding that adaptation is a pressing need for developing countries. An expert said the AR5 clearly indicates that while adaptation and mitigation act at different timescales we need to work on adaptation, mitigation and development at the same time. Another expert stated that to ensure that the adaptation gap is filled, we should first ensure that it is as small as possible, and that will be achieved through progress in mitigation. He emphasized the need to "act now on adaptation", underlining the need for communities to "learn by doing". Another expert added that one of the aims of the *Adaptation Gap Report* is to generate discussions on this issue. She stated that "there is no question there is such

---

[28] Climate Policy Initiative. 2014. *Global Landscape of Climate Finance*. Available at <http://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2014>.

[29] World Health Organization. 2014. Quantitative Risk Assessment of the Effects of Climate Change on Selected Causes of Death, 2030s and 2050s. Available at <http://apps.who.int/iris/bitstream/10665/134014/1/9789241507691_eng.pdf>.

a gap", expressing the hope held by UNEP that the report can generate a more strategic global thinking on adaptation and follow up with more specific analysis.

171. A Party made a comment on the limited carbon budget, calling on those countries that have "the capacity to do more, to do more", stressing that **the lesser the budget is, the greater the need to focus on the principle of common but differentiated responsibility**. An expert said the mitigation analysis in the *Emissions Gap Report* is done at the global level and does not interfere with the application of the Convention's principles. He added that the report also points to opportunities across sectors and to co-benefits that will drive action at various levels.

172. A Party asked if the World Bank's findings on **commoditizing carbon** are cost-effective in developing countries, which often have single commodity economies, and/or do not have mature markets. In relation to setting the price of carbon, he also asked whether the World Bank would seek to interfere with the market price or impose restrictions, stressing the freedom of the markets. An expert emphasized that the World Bank refers to "pricing carbon" as a generic phrase, aware of the fact that each country will pick the instrument that is best suited to the national circumstances, either a tax or a market. He referred to the Partnership on Market Readiness, which is a grant-based global partnership of developed and developing countries that provides funding and technical assistance for the collective innovation and piloting of market-based instruments for GHG emission reduction. He said the partnership also provides a platform for technical discussions of such instruments to spur innovation and support implementation. He added that in countries with weak institutions and low income, carbon taxes are much simpler than market-based instruments. He emphasized that all the instruments aim to raise revenues, which can be used to alleviate the shock of fossil fuel subsidy reforms, as has been the case in Ghana and Indonesia.

173. Commenting on a presentation that indicated that **poverty is decreasing**, one Party questioned the veracity of this finding. An expert confirmed that extreme poverty has been reduced in the past 20 years. The international poverty line is set at USD 1.25 per day in purchasing power parity; 42 per cent of the world's population was below that line 20 years ago. Today, this has been reduced to 17 per cent. He pointed to some caveats to this finding, including that poverty cannot be described solely through purchasing power as it is more complex, and that significant regional differences in poverty levels exist.

174. On energy and climate change, one Party commented that **investment in fossil fuels is still dominant** because it is a sustainable supply of energy and does not require subsidies on the production side. On **carbon intensity**, the same Party asked how to classify the carbon intensity of various energy sources, such as coal and gas. An expert welcomed the focus on carbon intensity, noting that it helps illustrate "what you need to do to make the transition" to a low-carbon economy rather than the goal itself. She added that one should look at the end uses of energy rather than examine the carbon intensity of various fuels. The power sector is projected to decarbonize rapidly because there are many choices for power generation. In the IEA models, the average emission intensity of the power sector goes below that of natural gas generation in the mid-2020's and continues downwards, led by new investments in low- or zero-carbon power generation. Changes in carbon intensity in the transport sector are much slower.

175. Noting that many developed **economies are driven by taxes on fossil fuels** that provide a major source of revenue, a Party asked how reduced demand for fossil fuels may affect these economies. An expert stated that the Organisation for Economic Co-operation and Development (OECD) is currently carrying out some research on how other policy areas than energy and climate will be affected by this transition and whether they support the transition, including tax and trade policies. The expert stated that a paper on this matter should be released in 2015.

176. A Party noting that scenario RCP8.5 projects an increase in temperature of 4–5 °C, asked for **clarification about the reference to a 6 °C scenario and its basis**. An expert explained that the reference to 6 °C is a long-term stabilization level rather than a 2100 level.

177. A Party asked about strategies to address **energy poverty**. An expert pointed to an IEA analysis that found that providing universal access to basic electricity for the 1.3 billion people who do not have it would

imply an increase of less than one per cent in global emissions.[30] She stressed that meeting these basic energy needs should therefore "not be an excuse" for very large emission increases. Another expert pointed to a World Bank report on the co-benefits of climate policies, which indicates that the energy poor use biomass with very bad health consequences, batteries or costly generators.[31] He added that providing clean sources of energy to these people therefore has significant development gains and should be one of the priorities of the energy sector.

178. A Party asked WHO to clarify its reference to **"uninhabitable places"**, stressing that his country was very uninhabitable. An expert stated that some countries had done a "great job" of making themselves very comfortable, reiterating the point made by another expert earlier on the need to address mitigation, adaptation and development simultaneously. She called on other countries to learn from those countries living with very high temperatures, stressing the need to facilitate lessons learned across countries, taking into consideration various development contexts.

179. A Party asked FAO about the **potential savings that could be generated by changing lifestyles and reducing food consumption and food waste**. The same Party asked about the impacts of ethanol production on food security and its carbon footprint. An expert underlined that the carbon footprint of bioenergy varies greatly depending on the biomass used, the country where it is produced or the technology used. He stated that it is difficult to generalize, but that the carbon footprint of bioenergy generally is decreasing. There could be value in developing technologies now that will have a reduced footprint in the future. On the impact of bioenergy production on food security, he said this is a very complex question and referred to the report of the High-Level Panel of Experts on Food Security and Nutrition, which was prepared at the request of the Committee for World Food Security.[32] The report indicates that the impacts of bioenergy on food security are very diverse and depend on the area of production of biofuels, but also on the timescale used. He underlined that in some countries, bioenergy production can have an impact on food prices, but it is also is a driver of development and can lift people out of poverty and reduce energy poverty. He added that modern forms of biomass can be healthier and more efficient for a lot of uses, including in agricultural production. Noting that food demand is projected to increase by 60 per cent while the population is projected to increase by 30 per cent, he emphasized the need to limit demand through changes in diets and lifestyles. He stressed that it is more difficult to act on consumption than on production patterns.

180. A Party asked for confirmation that the AR5 indicates that **mitigation** action would come with important economic and social **co-benefits** and increases in energy security. Noting that immediate mitigation action is required in 1.5 °C scenarios, he asked if this would imply that the co-benefits of mitigation action would materialize earlier in these scenarios than in 2 °C scenarios. An expert said the co-benefits of mitigation action are clear, but **challenges exist in terms of measuring and defining them.** On the differences in the materialization of co-benefits in 1.5 °C and 2 °C scenarios, he said he was not aware of any study that examined this question.

181. A Party referred to the IEA presentation outlining emission reduction measures at zero GDP cost, in particular calling for the **removal of inefficient fossil fuel subsidies** which could reduce post 2020 emissions by about 12 per cent, adding that this can often bring a GDP benefit. He pointed to recent developments on this issue within the Group of Twenty (G20) and the Asia-Pacific Economic Cooperation (APEC) forum and in the post-2015 development agenda negotiations. An expert welcomed the developments mentioned, noting that they are success examples that provide an incentive for other countries to also remove fossil fuels subsidies. He explained that originally, such subsidies were generally put in place to help the poor access energy and help industry develop and create jobs. These two objectives can be achieved much more efficiently through other measures, for example with cash transfers for the poor, infrastructure development, or decreases in taxes on industry. Carbon pricing would make little sense in a place with massive fossil fuel subsidies, where the first step should be subsidy reform. In all cases, there is a focus on the poor and ensuring that they benefit from the

---

[30] IEA. 2011. Energy for All: Financing Access for the Poor. Available at <http://www.worldenergyoutlook.org/media/weowebsite/energydevelopment/weo2011_energy_for_all.pdf>.

[31] World Bank. 2014. Climate-smart Development: Adding Up the Benefits of Actions that Help Build Prosperity, End Poverty and Combat Climate Change. Available at <http://documents.worldbank.org/curated/en/2014/06/19703432/climate-smart-development-adding-up-benefits-actions-help-build-prosperity-end-poverty-combat-climate-change-vol-1-2-main-report>.

[32] Available at <http://www.fao.org/cfs/cfs-hlpe/reports/en/>.

reform. Another expert added that fossil fuel subsidy reform is a cost-effective measure for many countries, emphasizing that often the reform will be triggered by non-climate benefits.

182. A Party noted that the **emission-intensity is agreed inside the agricultural sector** and is well understood outside that sector. He asked about relevant FAO work on the use of emissions per unit of food and goal setting.

183. A Party asked **how important the Paris agreement is to get a switch in energy investment towards the decarbonization needed to get the world on a 2 °C pathway**, in particular to materialize the 80 per cent cost-neutral investments that were mentioned. An expert said the IEA sees the Paris agreement as very important, especially in the shift in investments in long-lived infrastructure, where investors need a long-term signal that such investments will be 'smart'. In relation to cost-neutral measures that can drive emission reductions before 2020, she stated that the Paris agreement can also play some role in providing an incentive for all actors to take early action if they know that stringent targets will be set in the near future, but action should happen with or without an agreement.

184. A Party asked about the importance of the **decarbonization of the electricity sector for limiting warming to 2 °C above pre-industrial levels.** Noting that in IPCC scenarios limiting global warming below 2 °C, this decarbonization happens around 2050, he also asked when the carbon intensity of this sector approaches zero in the IEA models. An expert stated that the IEA model indicates that electricity needs to be largely decarbonized by 2050, so under the same timeframe as that indicated by the IPCC in the AR5, adding that this will underpin the decarbonization of other sectors.

185. A Party referred to the **difficulty of defining adaptation funding**, asking if disaster relief would be considered adaptation funding, and what types of public and private funding could be considered as adaptation funding. He also asked for clarifications regarding the limitations and uncertainties related to the cost estimates of adaptation. An expert indicated that **disaster relief is not considered as adaptation funding** in the UNEP *Adaptation Gap Report*, which only includes funding for adaptation that is qualified as 'significant' or 'principal', as defined by the OECD database. He added that **funding for disaster risk management is increasingly being included** in estimates of adaptation finance flows. He recognized that there are high uncertainties in the cost estimates of adaptation because of the little data available to assess the effect of the measures. Although we are at the early stage of costing adaptation, a lot of progress has been made to lower these uncertainties. He also specified that private sector finance was not included in the estimates in the UNEP report because of the **inability to track private sector activities in adaptation.** Another expert emphasized that there are great **differences among sectors in relation to where the funding is going.** For example, only three per cent of the Least Developed Country Fund resources are going to the health sector. Another expert explained that the WGII report does not contain an adaptation gap dollar figure because many investments can be legitimately linked to adaptation or to another objective. To recognize this diversity of objectives, the IPCC decided that it was best not to identify a particular number.

186. A Party asked about the **reliance on nuclear power to achieve 2 °C** scenarios and negative emissions. An expert indicated that the WGIII assessed the impacts of the changes in the technology portfolios on the mitigation costs in figure 17.15 of the WGIII report. It found that a **moderate phase out of nuclear power can easily be substituted by renewables** because it is a flat optimum. However, there are multiple pathways to achieving low stabilization limits in a cost-effective way, for example through high energy efficiency and renewable energy, or through high shares of nuclear and CCS. He underscored that CCS is an exception, as it is particularly important in combination with bioenergy. He added that CCS technology has two functions: it prolongs the life of fossil fuels; and more importantly, it plays a role in producing negative emissions that counter historical emissions and emissions in other sectors that cannot be reduced to zero. Another expert explained that in the IEA 2 °C scenario, nuclear energy plays an important but supportive role, as it is part of the low-cost package.

187. A Party asked about the **release of large GHG reservoirs associated with hydropower generation.** An expert pointed to the *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*,[33]

---

[33] IPCC. 2011. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Available at <http://srren.ipcc-wg3.de/report>.

which indicates that the emissions released from the reservoirs depend on what was on the land that was flooded by the reservoir, but that they would be quite small compared with the emission reductions achieved through hydropower.

188. Noting that to guide the next review the IPCC may conduct a paper on agriculture, climate change and food security, a Party asked **what aspects of the AR5 would be a valuable input to such a paper,** and what the **primary research gaps** are in this space.

189. A Party said that adaptation and mitigation should be put in the broader context of finance and technology argued that **it is optimistic to state that achieving the 2 °C pathway is technically and economically feasible,** emphasizing that economic and technological resources are distributed unevenly at the regional and national levels, and asked if this was considered in the analysis. An expert explained that the World Bank looks at the difference between the economic costs and the financing needs, stressing that some of the measures that have net benefits in economic terms may require a lot of up-front investment and less operational costs. He said that if the constraints are financial, these measures may be very difficult to put in place. As a result, financing instruments will play a key role in the transition to a low-carbon economy, especially in a world where we are still lacking USD 1.0–1.5 trillion per year in investments. He indicated that the World Bank is working to provide solutions to this investment gap, most probably through a package of measures. He added that carbon pricing could provide some of the financing that is needed to achieve the climate goal. Another expert underlined that the analysis carried out for the *Emissions Gap Report* is carried out at the global scale, however, all the editions of the report have included a chapter on what can be done, using examples at the country level. Yet another expert added that the WGIII chapter on regional costs and feasibility indicates that it is not just an issue of technical feasibility, but also a question of regional distribution of costs. He pointed to remarkable differences across the regions, stating that it all pertains to the distributional aspect of the whole problem and how to organize transfers and financial support.

190. A Party asked if an **analysis of the barriers to adaptation technology transfer** had been carried out, and if experts could provide some recommendations on how to overcome these barriers. An expert pointed to the World Bank's *Green Growth Report*,[34] which stresses that transfer is not the only issue, emphasizing the important need for technology to be adapted to the local context in order to be effective. He also stated that trade barriers can sometimes constitute a significant obstacle to technology transfer. Another expert said there is expert judgment that goes into the IEA scenarios on how quickly different technologies would be taken up in different regions. She added that just because a measure could be taken at zero GDP cost, it does not mean that it would be easily implemented, stressing that some capacity and finance issues would need to be overcome. Yet another expert clarified that the *Adaptation Gap Report* refers to a barrier analysis of technology transfer. She indicated that the technology chapter primarily builds on lessons learned from the technology needs assessment project funded by the Global Environment Facility (GEF), which UNEP helped implement. The main barriers identified are: financial barriers; regulatory and legal frameworks; technical barriers to the development and transfer of technology; and institutional and organizational barriers.

191. A Party asked if there was **anything else that should be done in the UNFCCC process, aside from negotiating the Paris agreement, to speed up the transformational change** required to drive down emissions. An expert encouraged the UNFCCC to **look at the issue in a more holistic way, and not only focus on emission reductions targets every few years but also on the energy sector transformation that is required** to ensure that the needed infrastructure is in place. Another expert called for an **increased focus on adaptation and development**, underlining the tendency to focus on one element of the problem at a time and stressing the need to "look at the full picture".

192. A Party asked about the **impacts of air-borne desert dust particles**, which are considered the primary cause of premature death in the Middle East, and are projected to increase with climate change and the resulting increased desertification. He also asked if any analysis has been carried out on the possible feedback of desert dust particles on climate change. An expert indicated that WHO is well aware of the health impacts of desert dust particles, but that there is relatively little literature on the issue. She noted, however, that more research is currently underway for various regions, and that the literature is becoming large enough to be assessed. Another

---

[34] World Bank. 2012. Inclusive Green Growth: The Pathway to Sustainable Development. Available at <http://siteresources.worldbank.org/EXTSDNET/Resources/Inclusive_Green_Growth_May_2012.pdf>.

expert pointed to the IPCC Special Report on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*,[35] which touched on the health impacts of desert dust particles, but was unable to distinguish a separate climate change cause for these impacts. He also mentioned that WGI examined the impacts of dust as a climate forcer, but did not carry out a separate analysis of desert dust. He said these are opportunities for future research and assessment.

193. A Party questioned the fact that **floods are disproportionately affecting the poor in Mumbai**, as presented by the World Bank. He explained that most of the impacts of floods in Mumbai are due to the inadequacy of the services provided, such as sanitation, as well as heavy rain coinciding with high tides. He added that with improved services, another Indian city has had some success in reducing the impacts of flooding. An expert recognized that, in both developed and developing countries, the land markets are pushing people out onto land that are exposed to flooding. He pointed to the success of disaster risk management when a hurricane hit India in 2013, demonstrating that cheap solutions, taking into account the local context, can save thousands of lives.

194. A Party asked if an assessment of the national and local governments' efforts to minimize vector-borne and water-borne impacts after extreme events has been carried out.

D. Part 3: Information from United Nations and international organizations, and from processes under the Convention

1. Presentations by experts

195. Mr. Juan Hoffmaister, Adaptation Committee Co-Chair, presented on enhanced adaptation action in the context of the 2 °C limit to global warming. He listed the three workstreams of the Adaptation Committee's 2013–2015 workplan, namely: **technical support and guidance to Parties on adaptation action**; **technical support and guidance to Parties on MOI**; and **awareness-raising, outreach and sharing of information**. While noting that the Adaptation Committee's 2013–2015 workplan does not include a specific focus on the long-term global goal, he stated that the Cancun adaptation framework is flexible enough to respond to the issues emerging in the light of this goal, and that a new flexible workplan is being developed for 2016 and beyond.

196. He explained that the aim of NAPs was to reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience, and facilitate the integration of climate change adaptation into new and existing policies, programmes and activities, and development planning processes and strategies, within all sectors and levels.

197. Mr. Hoffmaister then described some experiences with NAPs, including: when preparing their national communications, most countries have already conducted an analysis of observed changes in the climate system, applied climate scenarios for projections and conducted vulnerability assessments; many LDCs can build on results from the assessments they have undertaken for their National Adaptation Programmes of Action; and Parties have reported challenges in using the latest IPCC scenarios to formulate and implement NAPs, as well as concerns regarding their applicability to specific and/or local contexts such as mountainous regions.

198. He mentioned **lessons learned in the formulation and implementation of NAPs** and national development planning, stressing the importance of an appropriate national mandate and high-level coordination mechanisms for adaptation. Among the many programmes and activities that countries have been, and are supporting, that already contribute to the objectives of the NAP process, he pointed to sector budgets, and projects aimed at alleviating poverty through enhancing the resilience of communities at the national and local levels to climate change risks and impacts. He underlined that some bilateral organizations are receiving very few requests from countries for support for the NAPs process, in contrast to the high number of requests for support under the NAP global support programme.

199. In addition, he reported that: organizations and agencies need to consider their organizational mandates, set-ups and resources in the light of the long-term nature of the NAP process; for many Parties, there is a lack of

---

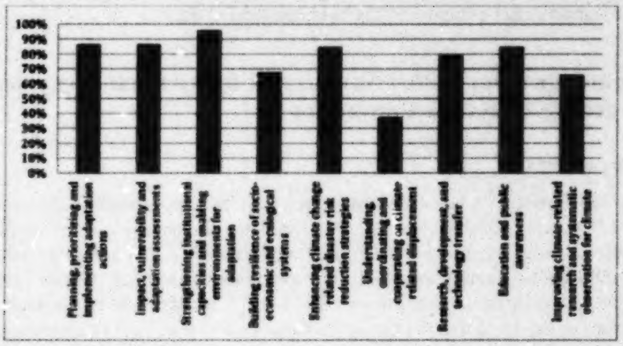
[35] IPCC. 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Available at <http://www.ipcc-wg2.gov/SREX/>.

clarity on procedures for applying for funding from the Least Developed Counties Fund (LDCF) and the Special Climate Change Fund (SCCF) for the NAPs process; and since both funds are based on voluntary contributions, some Parties suffer from inadequate and unpredictable financing that hinders further scaling up and mainstreaming adaptation into national development planning.

200. On the **monitoring and evaluation of adaptation**, he stressed that: appropriate monitoring and evaluation frameworks are needed, relevant to needs and tailored to country circumstances; due to the context-specific nature of adaptation, a common set of global indicators is not useful; national-level assessments can play a different role in measuring adaptive capacity from subnational or project-based assessments, for example, to measure the degree of coordination and integration of adaptation in national priorities; a positive learning environment is important; and planning and allocation of resources, both technical and financial, are key for effective monitoring and evaluation systems.

Figure 88

Mapping and analysis of support from United Nations agencies and regional institutions on adaptation (2013/2014)



Source: Slide 8 of the presentation by Mr. Juan Hoffmaister (Co-Chair of the Adaptation Committee (AC)), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_ac_co-chairs_sed4-2_feb8.pdf>. The figure indicates areas of support provided by organizations and United Nations agencies that share information with the Adaptation Committee (for details, see Adaptation Committee document AC/2014/7, available at < http://unfccc.int/8012.php>).

201. In closing, he presented a graph illustrating findings from mapping and analysis of support from United Nations agencies and regional institutions on adaptation, which indicates that all organizations and United Nations agencies that share information with the Adaptation Committee are providing support to strengthen institutional capacity, but that other issues, such as those associated with climate-related displacements, are not receiving support across the whole system (figure 88).

202. Mr. Paul Leadley, Coordinator of *Global Biodiversity Outlook- 4*,[36] delivered a presentation on connecting biodiversity with climate change mitigation and adaptation, which was prepared in collaboration with Mr. David Cooper, Director of Science, Assessment and Monitoring, CBD, and Mr. Phillip Williamson, Lead Author of *An Updated Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity*.[37] The main messages of his presentation were that: many organisms and ecosystems are already impacted by recent climate changes and additional change will exacerbate impacts; thresholds are often difficult to identify; **biodiversity can play an important role in increasing climate change resilience**; and **pathways to remain within 1.5 °C or 2 °C** of warming above pre-industrial levels **will require careful management to conserve biodiversity and ecosystems**, as well as to optimize their contribution to climate mitigation and adaptation.

---

[36] Secretariat of the Convention on Biological Diversity. 2014. Global Biodiversity Outlook. Available at <http://www.cbd.int/gbo4/>.

[37] Secretariat of the Convention on Biological Diversity. 2014. An Updated Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity. Available at <http://www.cbd.int/doc/publications/cbd-ts-75-en.pdf>.

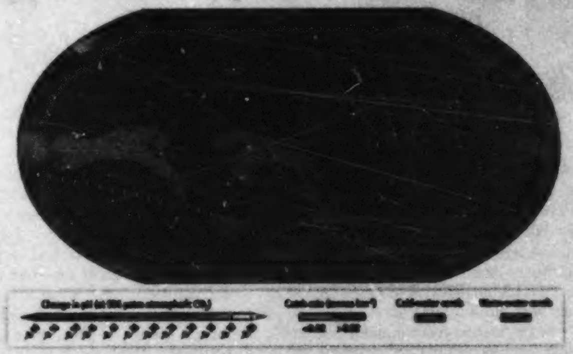
203. He explained that ocean acidification is a direct response to rising atmospheric CO_2, involving more dissolved CO_2, bicarbonate ions (HCO_3^-) and hydrogen ions (H^+) (i.e. lowered pH) but less carbonate ions (CO_3^{2-}). He said marine organisms can react to any of these changes, and different organisms react in different ways. He pointed to the interactions with: other climate-related stressors (e.g. warming, hypoxia); indirect pH effects (e.g. increased metal toxicity); food and nutrient availability; and biotic factors (e.g. food web changes, competition). While noting the pole-ward migration of marine species due to temperature changes, he underlined that ocean acidification reduces species' ranges.

204. On the **difference between CO_2 levels associated with 1.5 and 2 °C warming**, he stated that ocean acidification already causes impacts on marine species, and that any additional increase of atmospheric CO_2 and other stressors will progressively increase the ocean acidification risk to biodiversity (figure 60 above).

205. On the **natural capacity of marine organisms to adapt**, he noted that Palaeolithic-evidence shows natural ocean acidification events, albeit at much slower rates than today, which caused the extinction of many benthic species. Some experiments show that there is capacity to adaptation to lower pH, but it is very limited. Natural experiments around CO_2 vents in shallow seas show that there is a dramatic loss of biodiversity. He added that even if some species can adapt, ecosystem changes will occur, and there will also be corrosion of unprotected carbonate structures (e.g. cold-water corals) in unsaturated waters. Mr. Leadley stated that the impact of ocean acidification on warm-water corals is also of concern, since the lower pH affects their ability to calcify and hence population recovery from bleaching. He underlined that reef loss affects many other species and increases the impacts of sea-level rise. Warm-water coral reefs are already under stress, with more than 50 per cent currently in poor health, while cold-water corals are at risk from the increasing area of seafloor experiencing aragonite saturation of less than 1.0. He said that protecting coral reefs requires combining global action (i.e. CO_2 emission mitigation for climate and ocean acidification) and local action (i.e. the protection of herbivorous fish and pollution controls) (figure 89).

Figure 89

Species vulnerable to ocean acidification – of high socioeconomic or ecological importance



Source: Slide 9 of the presentation by Mr. Paul Leadley (Convention on Biological Diversity), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_cbd_sed4-2_feb8.pdf>. The figure indicates known locations of cold- and warm-water corals, depicted on a global map showing the projected distribution of ocean acidification under RCP8.5 (pH change from 1986–2005 to 2081–2100)

206. Mr. Leadley then focused on **forests**, noting that they are being negatively impacted by climate change sooner than had been anticipated, and that impacts vary substantially across tree species and regions (AR5, WGII chapter 4). He stressed that: reinforcing species and genetic diversity of trees can enhance the adaptive capacity of forests to climate change; reducing deforestation can contribute both to climate change mitigation and biodiversity protection; using diverse tree species mixes or natural regrowth for restoration can contribute to climate change mitigation and biodiversity protection; planting forests could make important contributions to future bioenergy, but if they replace primary forest they have negative impacts on biodiversity and medium-term climate balance.

207. He underscored that since the **conversion of tropical forests to plantations** has very large, long-term, negative impacts on biodiversity and soil carbon stocks, leaving tropical forests intact is 'a win-win', hence the

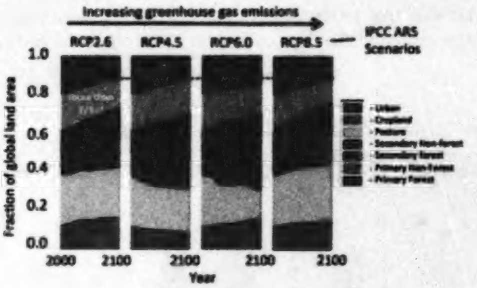
importance of REDD plus.[38] He then explained that the *Global Biodiversity Outlook* indicates poor progress on halting deforestation of primary forests globally, with the exception of a 70 per cent reduction in deforestation in Brazil. He added that progress can be made but depends on, inter alia: good governance; publically available monitoring of deforestation; public awareness; the expansion of protected areas and demarcation of indigenous lands; incentive measures; and willingness to move forward.

208. On **reforestation**, Mr. Leadley underscored that, if appropriately done, active and passive forest restoration can have large positive benefits for climate mitigation, biodiversity and ecosystem services. He explained that while massive reforestation efforts are made globally, some are carried out with monoculture and exotic species, and hence have poor biodiversity benefits. While recognizing the complexity of optimizing co-benefits for biodiversity, climate mitigation and other ecosystems services for restoration projects, he stressed that new decision support tools can help evaluate trade-offs.

209. Mr. Leadley then examined the **primary land-use scenarios** associated with the four of the RCP scenarios, highlighting that in **RCP2.6, more than a third of primary forests was lost**, and that none of the other RCP scenarios had a positive impact on primary forests (figure 90). He stated that the other scenarios are "not very good for primary forest either" due to the negative effects of climate change on primary forest.

Figure 90

Primary land-use scenarios associated with the four representative concentration pathways scenarios

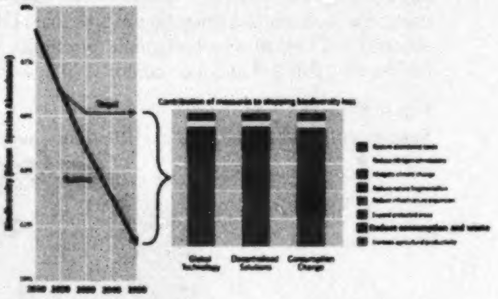


Source: Slide 13 of the presentation by Mr. Paul Leadley (Convention on Biological Diversity), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_cbd_sed4-2_feb8.pdf>. The figure shows changes in the global land use during the course of this century expressed as fractions of total land area for various RCPs. The red horizontal line indicates the remarkably similar loss of primary forests in all four scenarios by 2100.

Abbreviations: RCP = representative concentrations pathways. IPCC AR5 = Fifth Assessment report of the Intergovernmental Panel on Climate Change.

Figure 91

Achieving the Convention on Biological Diversity 2050 Vision and ties with Sustainable Development Goals



Source: Slide 14 of the presentation by Mr. Paul Leadley (secretariat of the Convention on Biological Diversity (CBD)), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_cbd_sed4-2_feb8.pdf>. The figure shows current trends in biodiversity loss (left panel, red line) and the CBD conservation target (green curve). The right panel shows three alternative scenarios of policy measures (global technology, decentralized solutions, and consumption change), each achieving the same conservation target while also reaching climate as well as sustainable development goals. The importance of reducing consumption and waste was underscored.

210. He therefore called on the IPCC, the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) and the UNFCCC to work together to meet climate and biodiversity targets and other sustainable development goals, in particular to: stop biodiversity loss by 2050; meet the Millennium Development Goals, with a focus on eliminating hunger; and keep global warming below 2 °C above pre-industrial levels. He presented three such possible alternative scenarios that will meet all the goals together, based on the IMAGE model, for achieving the 2050 Vision, emphasizing the importance of reducing consumption and waste (figure 91).

---

[38] In Decision 1/CP.16, paragraph 70, the Conference of the Parties encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities: reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks (REDD).

211. Mr. Sergio Zelaya, Special Advisor on Global Issues, UNCCD, gave a presentation titled "Desertification and land degradation and their impact on natural ecosystems and food security, a UNCCD response to the 2 °C target".

212. He presented some global facts on land, including that: global arable land represents 1/32 of the planet surface; 52 per cent of agricultural land is affected by degradation; land sector emissions amount to 6.2 Gt CO_2 eq per year; 1.8 billion of the world's population in 2025 will be living with absolute water scarcity and two-thirds (or 5.3 billion) could live under water stress conditions; land degradation over the next 25 years may reduce global food production by up to 12 per cent, and lead to an increase of as much as 30 per cent in world food prices; the world's drylands represent 40 per cent of total land mass, a third of the population, and 44 per cent of the food production system; 925 million people are hungry, including 80 per cent of smallholder farmers and the landless poor in rural areas; 40 per cent of interstate conflicts are associated with land and natural resources; and some 135 million people may be displaced by 2045 as a result of desertification.

213. After providing some definition of basic terms related to land and land degradation, he focused on the interaction between land and climate, underlining that small changes in that interaction can cause larger global changes. Pointing to AR5 findings, he explained that: dry areas are expected to increase in many parts of the world, increasing the current extent of semi-arid areas and the risks to the proper functioning of ecosystems; as the productivity and availability of land resources falls, so does adaptive capacity and resilience; and the unsustainable use of natural resources for food and energy causes land degradation locally, increases carbon emissions, reduces biodiversity and diminishes rainfall at multiple scales.

214. He pointed to common approaches to climate change mitigation and adaptation for addressing land degradation in drylands today and in non-dryland areas at risk. Noting that a large proportion of land ecosystems used for provisioning services is 'degraded', mostly due to the modes of use, he called for non-degraded productive land, land under restoration in drylands and land at risk of becoming drier to be addressed by exploring, identifying and further improving sustainable land management (SLM) methods and practices.

215. Mr. Zelaya explained that UNCCD adopts a holistic approach to land management and land degradation by aiming at land degradation neutrality. He outlined some benefits of land degradation neutrality, namely: its low cost, with an estimated average cost for land restoration of EUR 130 per ha or 0.45 Gt CO_2 eq while the economic rates of return of conservation, rehabilitation and SLM could reach 12–40 per cent; its multiple benefits, such as improved livelihoods in terms of food and water security, productivity increase and employment options; and its contribution to a low-carbon world, since the restoration of 12 million ha/a year could sequester 6.75 Gt CO_2 eq/year.

216. He underlined that land degradation neutrality is an ecosystem approach but that it is not a global target as it is still under negotiation, and each country can determine its level of ambition. Mr. Zelaya pointed to UNCCD COP decisions on the bottom-up target approach, noting their coherence with the UNFCCC process.

217. In closing, he outlined five opportunities for UNCCD to support Parties by: (i) providing support to the formulation of their INDCs in relation to key information on land use; (ii) integrating and combining sources of data for INDCs to assess the mitigation potential of existing plans and policies for land rehabilitation using IPCC default stock change and emission factors; (iii) setting up national land use mitigation targets and identifying their potential and co-benefits; (iv) focusing action on achieving land degradation neutrality as a starting point when reporting on INDCs implementation; and (v) providing land-based indicators common for reporting on climate change adaptation and mitigation, and on progress on land degradation neutrality and SLM.

218. Mr. Amena Yauvoli, SBI Chair, gave a presentation on supporting adaptation and mitigation action through capacity-building and education. He described the Durban Forum on capacity-building, which was established in 2011 by decision 2/CP.17, and whose mandate was expanded with decision 10/CMP.8 to cover issues relating to capacity-building under the Kyoto Protocol. The forum, which is organized by the SBI, has held three annual in-session meetings so far, with the next scheduled to take place during SBI 42, in June 2015.

219. The Durban Forum aims to: enhance the monitoring and review of the effectiveness of capacity-building; exchange experiences, good practices and lessons learned; provide an overview of capacity-building elements in the work of bodies established under the Convention and its Kyoto Protocol; and provide inputs to the review of the framework for capacity-building in developing countries. He underlined that the participatory

mechanisms of the Durban Forum are very broad based, and the agenda is usually driven by Parties through submissions on possible topics.

220. At previous meetings, Durban Forum participants have **discussed** ways to further enhance the monitoring and review of the effectiveness of capacity-building, the creation of an enabling environment, and capacity-building for adaptation and mitigation and gender mainstreaming. Mr. Yauvoli indicated that discussions held at each meeting of the Durban Forum are summarized in a report, which is forwarded for consideration to SBI.

221. He reported that **Durban Forum meetings are confirming that** there is a variety of activities to build capacity to mitigate and adapt to climate change that are embedded in mitigation and adaptation projects, and that bodies established under the Convention and its Kyoto Protocol are engaged in capacity-building activities, mostly at the regional level.

222. Among the **lessons learned** from the 2014 meeting of the Durban Forum, he highlighted the need to: build capacity to generate a higher level of social awareness of climate change and its impacts; actively coordinate stakeholders involved and identify the 'right' stakeholders and institutions to be trained to ensure that capacity-building efforts are effective; and enhance South–South and peer-to-peer cooperation to enable a strong cross-fertilization of ideas.

223. Mr. Yauvoli then described the **Dialogue on Article 6 of the Convention**, which was established in 2012 by decision 15/CP.18 under SBI. He explained that the Dialogue had held two annual in-session meetings so far, in 2013 and 2014, with the next scheduled to take place during SBI 42, in June 2015. The Dialogue on Article 6 of the Convention aims to provide a regular forum for Parties and other stakeholders to share their experiences, ideas, good practices and lessons learned regarding the implementation of Article 6 of the Convention. He noted that **participation in the Dialogue is broad-based**, and that the six elements of Article 6 of the Convention (education, training, public awareness, public participation, public access to information and international cooperation) are clustered into two focal areas that alternate on the Dialogue's agenda on an annual basis: the first area being education and training and international cooperation on these matters; the second, public access to information, public participation and public awareness, and international cooperation on these matters. He explained that discussions held at each meeting of the Dialogue are summarized in a report, which is forwarded for consideration to the SBI.

224. Among **messages emerging from the Dialogues**, he highlighted that: education and public awareness are fundamental for encouraging people to tackle climate change by changing their attitudes and behaviours towards climate-friendly lifestyles; climate change issues should be communicated in a manner that is understandable for all groups of society, attributable to daily life and does not create panic, but emphasizes opportunities; and the implementation of all elements of Article 6 of the Convention will contribute significantly to achieving the ultimate objective of the Convention and to implementing effectively adaptation and mitigation actions.

225. In concluding, Mr. Yauvoli underscored that **capacity needs to be built and education fostered in order to assess the adequacy of the 2 °C goal and the overall progress towards that goal**. He also said the Durban Forum and the Dialogue on Article 6 of the Convention can contribute to: promoting discussions among experts and practitioners; identifying lessons learned; replicating good practices and fostering action for emission pathways consistent with a 2 °C limit; and gathering information to support the review of the adequacy of the long-term global goal.

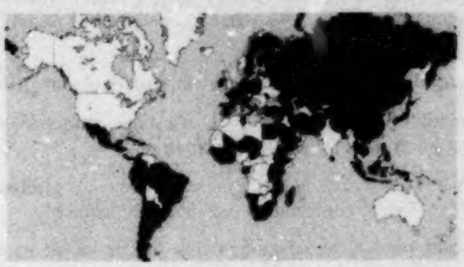
226. Mr. Jukka Uosukainen, Director, CTCN, gave a presentation on the development and transfer of technologies in the context of the 2 °C limit to global warming. He explained that, together with the Technology Executive Committee (TEC), the CTCN forms the UNFCCC Technology Mechanism, and is among the pre-2020 UNFCCC processes focusing on enhanced implementation. He added that while the TEC is the policy arm of the Technology Mechanism, the CTCN is the implementation arm, and aims to enhance action on the development and transfer of technology for action on climate change.

227. The CTCN mandate is to stimulate "technology cooperation and enhance the development and transfer of technologies to developing country Parties at their request". The CTCN offers the following three services: (i) providing technical assistance to developing countries; (ii) sharing knowledge and training; (iii) fostering collaboration on climate technologies, including linking climate technology projects with financing opportunity. The CTCN is hosted by UNEP, in collaboration with the United Nations Industrial Development Organization (UNIDO), and supported by 11 partner institutions with expertise in climate technologies.

228. Mr. Uosukainen indicated that as of 19 January 2015, 105 countries had selected their National Designated Entities (NDEs), stressing that the CTCN cannot render its services without an NDE and encouraging those countries who have not yet designated one to do so (figure 92).

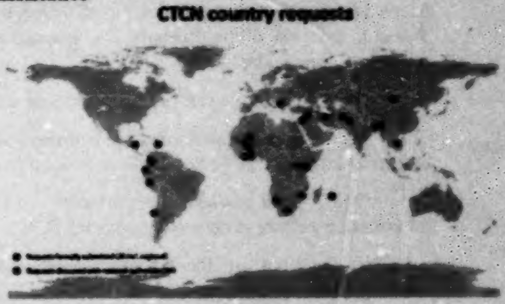
229. He described the **technical assistance** provided by the CTCN, stressing that it is: provided to developing countries upon their request; free of charge, with a value up to USD 250,000; both state of the art and locally-relevant expertise; provided to academics, the public, nongovernmental organizations or private entities; and for a broad range of adaptation and mitigation technologies.

Figure 92
Countries with designated national CTCN entities



Source: Slide 5 of the presentation by Mr. Jukka Uosukainen (Climate Technology Centre and Network), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/5_ctcn_sed4-2_feb8.pdf>. The figure shows a map of countries that have designated their national entities to the Climate Technology Centre and Network (80 developing countries).

Figure 93
Countries' requests to the CTCN for technical assistance



Source: Slide 8 of the presentation by Mr. Jukka Uosukainen (Climate Technology Centre and Network), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/5_ctcn_sed4-2_feb8.pdf>. The figure illustrates countries requests for technical assistance from the Climate Technology Centre and Network.

230. Mr. Uosukainen stated that through its network, the CTCN mobilizes policy and technical expertise from academia, civil society, finance and private sectors to deliver technology solutions, capacity-building and implementation advice to developing countries. He indicated that the CTCN had received 20 requests for technical assistance, some of which were already in the implementation phase, and that 14 additional requests are under discussion with national authorities (figure 93). He underlined the role of NDEs in coordinating the demands of their countries and explained that the assistance provided comes, at the moment, from the expertise of the 11 institutions that make up the consortium, but that the CTCN is looking to increase the number of its network members.

231. Mr. Uosukainen emphasized that the technical assistance provided by the CTCN is particularly quick, with expert teams set up in a couple of months and requests implemented within a year. He indicated that 72 requests (approximately 100 at the moment of writing this report) are anticipated in 2015, noting the need to maintain the balance between adaptation and mitigation requests, as well as among regions. He cited the examples of assistance provided to Colombia in relation to energy efficiency and renewable energy strategies, and to Iran on the design and manufacturing of photovoltaic solar cells. He underscored that the CTCN aims to link with all relevant activities under the UNFCCC process, such as the NAP and the technology needs assessment processes, in order to ensure coherence and coordination.

232. In closing, he underscored that: the TNA process and the work of the CTCN should be linked; the NDEs will play a key role, especially in bringing together all the relevant stakeholders; and technology support systems currently represent only a percentile of climate funding within the remit of the Convention, but it is fast growing.

2. General discussions

233. The ensuing discussion was guided by the following questions on theme 1 and theme 2 of the 2013–2015 review:

(a) Where has promising progress been achieved and what barriers to adaptation of which ecosystems, which agricultural systems, and which developing regions have been identified?

(b) What progress has been made in building capacity and educating on climate change? What are the main barriers to these efforts? What could be done to overcome these?

(c) What success stories exist in relation to national and regional actions that have enhanced the effectiveness of technology policies?

(d) What progress has been made on funding for climate action? What barriers and opportunities exist for the scaling-up of climate finance flows?

(e) Can ecosystems adapt naturally with respect to the transformation pathways compatible with a long-term global goal of 2 °C or 1.5 °C respectively? Which ecosystems are the most at risk? Which the least? What is the role of biodiversity for adaptation in general and which specific opportunities exist, such as ecosystem based adaptation?

(f) What role can capacity-building and education play in achieving the long-term global goal?

(g) Which transformation pathways compatible with 1.5 °C or 2 °C warming compared with pre-industrial levels are projected to threaten food production or offer the most opportunities?

(h) What barriers or opportunities to CSA and adaptation in the fisheries sector are projected to exist for emission pathways consistent with 1.5 °C and 2 °C warming compared to pre-industrial levels?

(i) What are the key opportunities for and barriers to adaptation that are projected to exist for emission pathways consistent with 1.5 °C and 2 °C warming compared with pre-industrial levels?

(j) What level of climate finance will be required to achieve the long-term global goal? What are the key factors that need to be in place to ensure that such a level is reached?

234. A Party asked about the **impact of land degradation on natural ecosystems and food security and linkages with the INDCs**. He noted that USD 1.7 billion will be required to achieve land degradation neutrality, and that INCDs are expected to clearly define the MOI in accordance with the Convention. He asked for clarification of the **role of INDCs in achieving land degradation neutrality**. Another Party asked about the **connections among actions aimed at protecting soils and halting land degradation, climate mitigation benefits and the price of carbon** and commented that the price of carbon would be higher in a world that is 1.5 °C warmer and that the higher price would thus have the co-benefits of halting land degradation. An expert explained that the target of 2 million ha of land restored proposed by UNCCD corresponds to the amount of land degraded annually. He added that the price of carbon used is based on the 2 °C scenario. He added that UNCCD is able to quickly assist those countries that wish to include the land component in their INDCs, pointing to challenges related to property rights and land tenure, and stressing that UNCCD would only use IPCC guidelines and methodologies for assessing the mitigation benefits. A Party further asked if, considering the USD 1.7 billion assessed by UNCCC, a link can be made with the financial mechanism under the Convention. He then asked if, at the next meeting of the SED, a GCF expert could provide information on the amount of finance available to support efforts to achieve land degradation neutrality. Mr. Zou Ji underlined that the Geneva meeting of the SED was its last.

235. A Party asked **how the CTCN plans to collaborate with the Durban Forum**, and if there are any capacity-building projects under the CTCN. An expert explained that he considers most of the CTCN activities to be capacity-building, underlining the importance of coordinating its work with the Durban Forum. He added that if requests for the services provided by the CTCN are not clearly defined then the CTCN works with the country in reformulating them, which is also a capacity-building process. He also pointed to an "incubator programme" for LDCs to help them define and identify their technology problems, which has already been used by approximately 10 LDCs. The expert also pointed to the organization by the CTCN of webinars that provide training on specific climate-related technologies.

236. A Party asked about the **impact of monoculture on biodiversity and genetic diversity**, noting that it may have climate mitigation benefits. An expert explained that, in many situations, genetic diversity provides many favourable outcomes and is useful in both tree plantation and restoration projects. He cautioned that "it is not always win-win", and that some species restoration projects will not provide the fastest carbon storage nor

the best resilience, hence the importance of support tools to evaluate the trade-offs between climate and biodiversity benefits.

237. A Party asked for **statistics regarding the amount of technology requests related to mitigation and those related to adaptation**, as well as information on the criteria used to prioritize requests. An expert replied that the 30 requests received so far by the CTCN are quite evenly distributed across regions and sectors. He said the CTCN has two sets of criteria for selecting requests. The first is an eligibility criterion, indicating that the request should support national climate efforts and support indigenous capacities in the country. The second criterion relates to prioritization in case the CTCN cannot serve all the requests received. In such cases, the CTCN is to ensure the balance between requests related to mitigation and those related to adaptation, as well as to serve LDCs and other vulnerable countries as a priority. He added that the CTCN currently has enough funds to serve all the requests received, but depends on bilateral funding from developed countries.

238. A Party noted that the presentation by the CBD had shown a clear difference in **impacts on ocean acidification and on coral reefs between 2 °C and 1.5 °C** of warming above pre-industrial levels. If there is a temperature overshoot, he asked how long, if at all, it will take for biodiversity to be restored. An expert indicated that if there is a temperature overshoot, which would be accompanied by a CO_2 overshoot, then the global water chemistry would take a very long time to recover, as shown by the Palaeo evidence (e.g. 10,000 years).

239. A Party asked for clarification on the CBD presentation regarding the modelling **and what is meant by reducing climate change, and whether it implies addressing global temperature increase or also other elements.** An expert explained that climate scenarios take into account emissions of CO_2, N_2O and CH_4 associated with all the different sectors, as well as other CBD targets, such as reducing deforestation, halting biodiversity loss, advancing human development, or ensuring sufficient food for everyone on Earth.

240. A Party pointed out that the workplan of the **Adaptation Committee does not have a specific focus on the long-term global goal**, and suggested that SED discussions be concentrated on the commitments under the Convention. While expressing his disappointment regarding the absence of a presentation on finance during SED 4, he asked if there are **initiatives under the Adaptation Committee on the consideration of commitments under the Convention relating to MOI**. An expert said that despite the absence of a specific reference to the long-term global goal in the workplan of the Adaptation Committee, which was adopted through a Party-driven process, it would be "difficult to argue" that NAPs are not contributing to the achievement of the long-term global goal. He stressed that it is up to **Parties to determine at the national level the level of risk they want to address.** On finance, he referred to ongoing work on adaptation finance carried out in collaboration with the Standing Committee on Finance, which examines national institutional arrangements, the NAP process and the challenges faced by countries in relation to access to finance and the integration of adaptation into national development plans.

241. A Party welcomed the use of the example of Brazil's efforts to reduce deforestation in the CBD presentation, but **underscored that tree mortality is increasing globally**, to some extent due to climate change, stressing that without global efforts to mitigate climate change, forests will continue to be threatened. An expert agreed, noting evidence showing that trees and forests are sensitive to temperature increases. He said that it is clear that the carbon stored in these protected areas is vulnerable to temperature increases, warning that with temperatures above 2 °C of warming, there could be very serious forest die backs in the Amazon.

242. A Party asked **which adaptation actions are the most urgent** to preserve coral reefs and food supply and protect biodiversity in the context of climate change and desertification, and **what kind of financial support is required** to promote adaptation and mitigate climate change impacts. An expert underlined that besides ocean acidification, coral reefs are also affected by coral bleaching and increased sea level, which are all impacts of climate change. He also pointed to local pressures on coral reefs, such as land-based pollution, overfishing, dangerous or disruptive fishing practices, and suboptimal coastal developments. He explained that countries can address these non-climate pressures through, inter alia, **reduced pollution and improved marine and coastal planning** in the short and medium term. He underlined that these measures will not bear fruit if they are not carried out in concert with global efforts to mitigate climate change. He also stressed the "enormous" benefits of protecting coral reefs, pointing to protection from erosion with a 97 per cent reduction in wave effects and support to local fisheries and tourism. An expert indicated that where marine protected areas have been

designated for coral reefs, some improvement has been seen in fish biomass and food web structure, but restoration has taken 10–15 years.

243. A Party asked for confirmation that **stringent mitigation pathways have considerable co-benefits for biodiversity** conservation or are essential to prevent biodiversity and ecosystem loss. She also noted that the **expected primary forest loss** in the RCP scenarios, which is very similar in all of them, does not take into account the climate change impacts on forests. She asked if these detrimental effects had been taken into account, the impacts of forest loss would be higher in RCP scenarios that do not keep temperature increase to low levels. An expert agreed that the greater the change in climate, the greater the threats to biodiversity. While recognizing that actions taken to address climate change action have clear biodiversity co-benefits, he warned that such action can also impact on biodiversity conservation. He called for attention to be paid to land-use change and emissions from the industry and energy sectors, as well as to the carbon stored in ecosystems beyond forests, including in the agricultural sector. He stressed the need for **building an incentive framework** that includes considerations of emissions from land-use change. He explained that in the **RCP2.6 scenario, the impacts from climate change on biodiversity are much reduced, but it implies significant land-use changes, which will be problematic for biodiversity**. He added that in order to reduce biodiversity loss, land-use change must be brought under control. He said that the scenarios presented indicate that it is **possible to achieve both the climate and biodiversity objectives** while ensuring food security, but this will not be an easy task and it will require adopting a very holistic approach. Another expert, noting some studies on geoengineering options that could locally raise the pH of oceans, stated that these options pose their own risks to biodiversity.

244. Another Party asked if **biodiversity loss projected for warming levels above 1.5 °C can be a damage multiplier of climate change impacts**, pointing to the coastal protection that coral reefs provide and that would be lost if they disappear (link through ecosystem services such as pollination, water purification and support for ecosystem based adaptation). An expert agreed that species extinction is a threat multiplier, underlining that the risk of extinction does rise from 1.5 °C to 2 °C of warming, but the details of how this will happen are not well known. While noting that evidence exists of the adverse effects of increased levels of warming on systems such as coral reefs or trees, he pointed to differences in impacts among regions and species. While recognizing that the details of the impacts of increased warming are not well known, he said that there is a high level of certainty regarding the fact that the risk to ecosystems and the services they perform rises with increased levels of warming.

245. A Party noted a paradox between the presentation by Mr. Leadley, who had said that the difference between 2 °C and 1.5 °C is really a matter of an increase in risk, while the SBSTA Chair had stated that what constitutes a tolerable risk may differ across regions, nations and sectors.

246. A Party noted that the Adaptation Committee reported that many bilateral organizations are receiving very few requests, indicating that the **utility of resources has been sub-optimal**. He asked how this opportunity could be better capitalized on. An expert explained that the fact that some bilateral institutions are not receiving many requests is not a challenge of optimal use, but **rather a challenge of institutional capacity**. He pointed to capacity constraints of some developing countries to make use of the existing opportunities. He indicated that in the future, bilateral agencies may support the global support programme if the countries feel more comfortable channelling their requests to the latter.

247. A Party asked how the **link between the CTCN and the NAP, TNA and nationally appropriate mitigation action (NAMA)** processes could be made more efficient, and requested more information on the LDC readiness programme within CTCN. An expert explained that to link the work of the CTCN to other processes, the CTCN will need to collaborate on the regional workshops planned for the TNA process, since the audience is the same, namely the NDEs. On the LDC capacity-building programme or ‘incubator’, he mentioned the caution of the CTCN to avoid overlapping with the capacity-building activities of other bodies. Noting that the Adaptation Fund is already carrying out some capacity-building and preparedness activities, he said the CTCN is looking at working in synergy with the Fund on this issue.

248. A Party asked about **non-climatic stressors** and possible success stories in addressing them that need to be taken into account when examining vulnerable ecosystems. An expert replied that while much research needs to be done on land ecosystems, evidence shows that land degradation is caused by human activities, but climate change exacerbates this trend, both in drylands and in non-dryland areas that are at risk. He called for addressing today’s drylands and not those that are at risk. He pointed to the proposal from the UNCCD to restore 12 million

ha of degraded land annually, stressing the need for it to be part of the solution to addressing climate change. He added that INDCs are a viable option for including such a land component and suggested that the GCF consider how this could be supported. Another expert said that non-climatic factors that are important include **invasive species**, which are the cause of the greater number of extinctions, especially on islands. He pointed to the example of New Zealand, which successfully restricts the introduction of invasive species and controls them once they have been introduced. He also mentioned the case of pollution in Europe, where there are relatively high nitrogen deposition rates, and where substantial progress has been made by countries in setting ecologically significant nitrogen level limits. A third added that non-climate stressors, such as pollution or sedimentation, pose risks to corals, but it will take a long time and more studies to be able to differentiate their impacts from those of climate change. He noted however, that studies show that when there is intense temperature elevation, irrespective of water quality, mass coral bleaching may occur. He stated that it can be concluded with **reasonable certainty that thermal stress is the key driver.**

249. A Party welcomed the discussions on the links between climate change impacts on biodiversity and desertification and non-climate drivers and asked **how well we understand the importance of different drivers, and what action to address climate change has co-benefits for biodiversity conservation or to combat desertification**. He also asked if the impacts of ocean acidification could be tied to the level of CO_2 in the atmosphere. An expert explained that acting on non-climate stressors is frequently a 'no regret' solution, and that measures aimed at, for example, **reducing nitrogen pollution or pressure on overfished resources**, will increase the resilience of ecosystems to climate change. He noted the limited understanding of all the interactions among these stressors, as often models only take into account a small number of interactions. He pointed to some regional tipping points mentioned in the *Global Biodiversity Outlook*, warning that "synergistic interactions could lead to many bad surprises". Another expert indicated that there is no consensus within the scientific community on any 'safe level' of ocean acidification and related CO_2 concentration in the atmosphere, but some literature places this safe limit for corals at 350 ppm, a threshold that has already been passed. A third expert explained that a study he co-authored was not included in the assessment carried out by WGI as it was published after the IPCC cut-off dates.[39] He said that the temperature target does not cover all the aspects touched upon in Article 2 of the Convention, calling for **ocean acidification to be considered in a separate manner**. While recognizing that limiting temperature limits ocean acidification to some extent, and that more information is needed on the regional impacts of ocean acidification, he underlined that a separate target on ocean acidification may set a much lower amount of CO_2 concentration increases in the atmosphere. Yet another expert explained that scientific knowledge on the climate and non-climate drivers of desertification and land degradation is insufficient and underlined that land ecosystems are not sufficiently included in climate solutions.

250. A Party noted that over 50 per cent of land degradation stress in Africa is climate-related, and asked **how to assess the risk of land degradation arising from both climate and non-climate stressors** in the light of the ultimate objective of the UNFCCC. An expert referred to the very large portion of the population, in particular in Africa, which is affected by land degradation, pointing to AR5 findings projecting that drylands will become drier and that a larger portion of terrestrial area will become drylands.

251. In response to a question by a Party on the **scale of funding required to address land degradation and desertification**, noting that the UNCCD presentation indicated that drylands are vulnerable and that 40 per cent of total land mass is dryland, the expert questioned whether the MOI available will be adequate to address the current level of drylands, or that projected at 1.5 °C or 2 °C of warming.

252. Noting that LDCs have various priorities related to development and poverty eradication issues, a Party asked if the recommendation to **mainstream adaptation in development planning**, which has a cost implication, is appropriate for LDCs. An expert indicated that whether countries decide to mainstream adaptation or carry out stand-alone projects depends on the types of hazards and exposure they are facing. He added that in the case of LDCs, the consideration of reducing vulnerability comes as a complement to the second objective of NAPs, namely the integration of adaptation to climate change into other policies.

253. A Party asked if the CTCN had received any **request relating to adaptation technology in Africa**. An expert indicated that the CTCN had received three following requests from African countries: from Mali on

---

[39] Steinacher M, Joos F, Stocker TF. 2013. Allowable carbon emissions lowered by multiple climate targets, Nature. 499:197-201.

resilient rural communities; from Cote d'Ivoire on climate information systems for both adaptation and mitigation; and from Namibia on transformation of water harvesting systems. He added that the CTCN encourages the replication of its response activities in neighbouring countries.

254. A Party underscored the **importance of the intersections of the three Rio Conventions**, suggesting that while developing their NAPs, Parties should involve the resources under these three Conventions. She also pointed to the challenges faced by experts carrying out vulnerability or impact assessments in using the new climate scenarios produced by the IPCC and called for discussion on how to simplify the use of the IPCC scenarios for performing national impact, vulnerability and adaptation studies. An expert stated that the collaboration of the three Rio Conventions could materialize in the context of ecosystem-based adaptation in the next workplan of the Adaptation Committee, which is under development.

255. Noting that his country is in the process of declaring their entire exclusive economic zone as a marine protected area and a sanctuary to contribute to halting biodiversity loss, a Party asked the experts to elaborate on **the role of biodiversity in rendering key ecosystem services**, the possible impacts of losing such ecosystems, as projected above 1.5 °C of warming, and their importance for the livelihoods of traditional and indigenous communities. An expert underscored the critical importance of other ecosystems aside from corals in supporting fisheries, such as mangroves or sea grasses. He added that often the smaller the country, the more its population's livelihoods are dependent on these ecosystems. He indicated that 30 million people are directly dependent on systems supported by coral reefs.

256. A Party asked about the **adequacy of the technology management system under the UNFCCC**, in particular about who owns and requests the technologies, as well as about the role of market-based mechanisms in encouraging the transfer of technology. An expert explained that market-based mechanisms have shown they can mobilize technologies, pointing to the example of the CDM, which has mobilized technologies in a wide range of countries. He cautioned that this mobilization is linked to the level of incentives, which is currently not very high, and therefore does not provide the level of trust or long-term certainty needed by private actors to invest in the technologies. Another expert explained that the CTCN aims to provide technology-neutral advice to countries, who can then follow up with requests for more detailed advice on a particular provider or technology. He explained that further to a request from Parties, the CTCN is examining whether to establish a library of technologies and their providers. He cautioned that this may entail "a huge amount of work" because of the constantly changing landscape of climate technologies. He added, however, that one could look at technologies mentioned in Parties' national communications and share that information through other countries with an automated system.

E. Part 4: Regional and emerging information

1. Presentations by experts on regional information on the observed impacts of climate change

257. The ensuing discussion was guided by the following questions on theme 2 (subparagraphs (a–d) below) and theme 1 (subparagraphs (e–k) below) of the review:

(a) What are the most recent findings in relation to observed regional impacts?

(b) Are there regions in which some ecosystems cannot adapt naturally? Is their adaptation assisted or might it help to assist them, and by which means? What are the consequences for agriculture and development?

(c) What challenges does global warming pose to agricultural practices, policies and measures, from a regional perspective?

(d) What challenges does global warming pose to sustainable development from a regional perspective?

(e) How has progress towards the long-term global goal varied across regions?

(f) How do opportunities and barriers to adaptation and mitigation vary across regions?

(g) Which risks vary the most across regions? How do these risks vary at various levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre- industrial levels?

(h) How do risks for vulnerable ecosystems vary across regions at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(i) How do regional food security risks vary at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

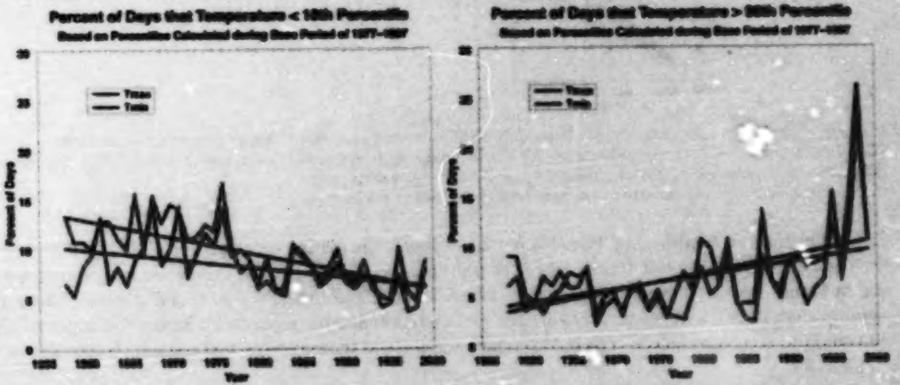
(j) How do observed impacts including those of sea level rise and extreme events vary across regions and at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(k) From a regional perspective, what is the future of ecosystems, agriculture and sustainable development in the context of climate variability, climate change and uncertainty about future climate conditions?

258. Mr. Leonard Nurse, Chairman of the Board of Governors, Caribbean Community Climate Change Centre (CCCCC), presented a Caribbean perspective on observed impacts of climate change. In terms of temperature changes, he stated that the observed changes in the Caribbean reflect global trends. Over the period 1950–2000, there have been more warm days and nights, and fewer cold days and nights, a trend that is increasing (figure 94).

259. On **observed rainfall**, the mean annual rainfall on average between 1900 and 2000 has shown a constant decline by around 0.18 mm per year. In the southern Caribbean, over the period 1900–1980, there has been a contraction in the 'traditional' wet season, which typically lasts from June to October. There have been longer dry spells and increasing drought incidences since 1900, and there has been an increase in the number of heavy rainfall events in last 75 years. He pointed to the example of Saint Lucia, which suffered its worst drought in 40 years in 2009–2010, and was then hit by Hurricane Tomas in 2010, which produced 25 inches of rainfall in 24 hours in some areas.

Figure 94
Observed extreme temperature trends in the Caribbean



Source: Slide 2 of the presentation by Mr. Leonard Nurse (Caribbean Community Climate Change Centre), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_cccc_sed4-2_feb9__1.pdf>. The figure shows for Caribbean since 1950 a growing trend in the number of warmest days and nights and a decreasing trend in the number of coldest days and nights.

260. As indicated in the AR5 chapter on islands, he reported that the **rate of sea level rise around islands** is generally higher than the global average: in the tropical Western Pacific, the rate of sea level rise is almost four times the global average; in the Indian Ocean, the rate of rise is as much as twice the global average; in the Caribbean, the rate of rise is generally higher than global average, at approximately 1.8 mm per year; and in the case of Guyana, where there is land subsidence, the observed mean rate of rise is approximately 2.4 mm per year (figure 95).

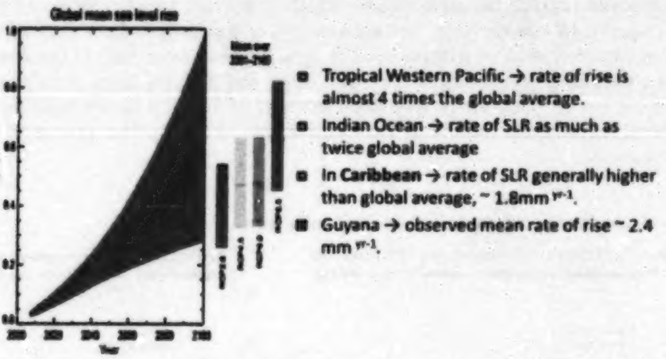
261. He underlined that the impact of climate change on **freshwater resources** is "a tremendous concern to our region", pointing to declining mean annual rainfall, more frequent and longer dry spells, higher evaporation rates, salinity intrusion, and increasing present and future demand.

262. On **coral reefs**, he underscored that these high-value ecosystems are at high risk, that the casual link between **ocean warming and coral bleaching** is well established and that an increase in water temperature of less than one degree is enough for bleaching to take place. Mr. Nurse added that many studies show that Caribbean reefs will continue to be severely degraded in the coming decades, based on the response of corals to thermal stress, and that there is no field evidence that corals can evolve and adapt to unabated thermal stress, certainly not on decadal timescales. While recognizing that other, non-climate stressors are important, he said the thermal stress is "the key signal".

263. He reported on findings emerging from an EU-funded study that were released in December 2014, titled "FORCE – Future of Reefs in a Changing Environment", which compiled information on **aragonite saturation** levels. He explained that aragonite is a mineral form of calcium carbonate ($CaCO_3$) found in corals and some other marine organisms, and that the lower aragonite saturation state of water is beginning to affect the development of the skeletons of corals. According to the AR5 projections, as the oceans continue to acidify, the impacts of climate change on reefs are anticipated to become more evident and significant.

Figure 95

Observed sea level rise in Small Island Developing States regions in the twentieth century



- Tropical Western Pacific → rate of rise is almost 4 times the global average.
- Indian Ocean → rate of SLR as much as twice global average
- In **Caribbean** → rate of SLR generally higher than global average, ~ 1.8mm $^{yr-1}$.
- Guyana → observed mean rate of rise ~ 2.4 mm $^{yr-1}$.

Source: Slide 4 of the presentation by Mr. Leonard Nurse (Caribbean Community Climate Change Centre), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_cccc_sed4-2_feb9__1.pdf>. The figure indicates that the rate of sea level rise in islands is generally higher than the global average.

Abbreviations: RCP = representative concentration pathway, SLR = sea level rise.

264. On **human health**, Mr. Nurse reported: a higher incidence of some vector-borne diseases since 1970, such as dengue fever, noting that some of the transmission factors are also climate sensitive; increased morbidity and mortality from hydro-meteorological events since 1950, particularly floods and storms; increased freshwater scarcity since 1960, with ensuing challenges for sanitation and hygiene; and a higher incidence of ciguatera fish poisoning in last four decades related to higher sea surface temperatures that provide favourable conditions for ciguatoxins.

265. On **tourism**, he highlighted direct and indirect effects from climate change: an increased risk to critical infrastructure such as air and seaports and accommodation; the amplification by sea level rise of ocean swell and storm surge elevations that lead to flooding, accelerated coastal erosion and land loss; and the loss of climate-sensitive attractions, in particular corals. He stressed that scuba diving "is not a trivial industry" and that revenues from scuba diving alone are significant in various Caribbean countries. For example, Bonaire earns over USD 50 million per year from recreational diver fees, and Belize earned USD 150–196 million from coral reef and mangrove-related recreation in 2007.

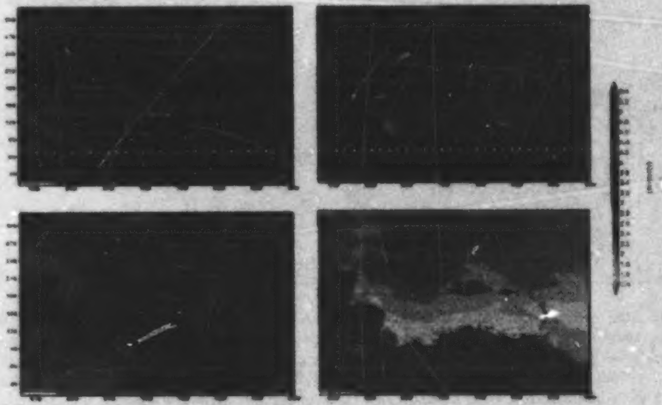
266. He presented some **downscaled projections for the region**, stressing that they are trending in the same direction as the observations, including: a projected 1–4 °C warming relative to 1960–1990 mean temperature by the end of the century; a projected 25–30 per cent decrease in rainfall before the end of the century; and a drying trend between -25 and -30 per cent by the end of the century, which far exceeds natural variability (figure 96).

267. Mr. Nurse then described the **Caribbean contribution to the achievement of the long-term global goal.** The Heads of State of the Caribbean Community and Common Market (CARICOM) mandated the CCCCC to develop a "Regional Framework for Achieving Development Resilient to Climate Change", which was approved in July 2009, and an "Implementation Plan". He said the Framework and Plan focus on key strategic elements, including economic trends and challenges, social sector trends and challenges, technology trends and challenges and energy for sustainable development. Mr. Nurse then focused on the energy pillar of the Framework. He reported that the Caribbean Community Energy Policy was adopted in 2013 and aims to transform the energy sector to provide clean energy. In January 2015, the Caribbean Energy Security Summit was co-hosted by the United States Department of State, the Council of the Americas and the Atlantic Council. The event brought together 26 countries, including all CARICOM States, who committed to "clean sustainable energy for all", and saw a pledge of cooperation from the United States Overseas Private Investment Corporation that proposed a clean energy programme in the Caribbean, including USD 43 million for a 34 MW wind energy project in Jamaica.

268. He also mentioned SIDS DOCK, an initiative developed by CCCCC and the South Pacific Regional Environment Programme (SPREP), which aims to: increase energy efficiency by 25 per cent compared with 2005 levels; generate a minimum of 50 per cent of electric power from renewable sources by 2033; and achieve a 20–30 per cent decrease in the use of conventional transportation fuel in SIDS by 2033. The partnership was established by a memorandum of understanding among the Alliance of Small Island States (AOSIS), the United Nations Development Programme, the World Bank and the Government of Denmark, and launched in December 2010 in Cancun, Mexico, with a USD 14. 5 million grant from the Government of Denmark.

Figure 96

Projected 1–4 °C warming by the end of the century (relative to 1960–1990 mean)



Source: Slide 11 of the presentation by Mr. Leonard Nurse (Caribbean Community Climate Change Centre), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_ccccc_ssd4-2_feb9__1.pdf Juan Hoffmaister>. The figure shows the projections for mean temperature in the Caribbean for an A2 scenario (upper panels) and B2 scenario (bottom panels) using ECHAM4 (left-hand side panels) and HADCM4 (right-hand side panels).

269. He stated that these programmes are bearing fruit, citing the successful example of the Wigton Wind Farm in Jamaica. He also mentioned: the deployment of renewable energy and energy efficiency in the public sector in Jamaica; the Sustainable Energy for the Eastern Caribbean project in Antigua and Barbuda, Grenada, and Saint Vincent and the Grenadines; and a sustainable energy programme in Guyana.

270. In concluding, Mr. Nurse emphasized that: climate change will continue to exacerbate existing challenges, as well as trigger new ones; **Caribbean countries believe that there is adequate, credible evidence to justify the pursuit of a long-term goal that limits global warming to 2 °C relative to pre-industrial levels**; delays in 'aggressive' mitigation will frustrate achievement of the long-term global goal and impose further limits on adaptation; and the Caribbean region has demonstrated a clear commitment to achievement of the long-term global goal.

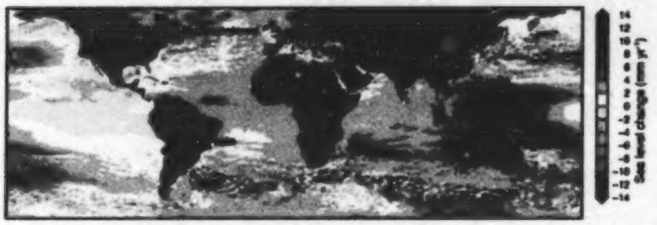
271. Ms. Diane McFadzien, Climate Change Advisor, SPREP, presented views from the Pacific. She underlined that in the Pacific region, the islands are very spread out and some have small populations, elements that have a direct relation with the people's adaptive capacity. She described some observed impacts of climate change in the Pacific region, underlining that capacity to document or research these impacts is limited in the region. She said observed impacts are in line with the findings of the AR5.

272. On **temperature rise**, she noted: a persistent regional warming trend since 1961 (0.18 °C annual), with the warmest years on record in the last two decades; an increase of more than three-fold in the frequency of warm days and nights; an increase in rare extremes from 20 days a year to 45–80 days a year; and an increase in sea surface temperatures across the Pacific. On **sea level rise**, she indicated that the observed rate of sea level rise in the western Pacific is three times above the global average for 1993–2012. While recognizing that this may mainly be attributed to natural variability, she stated that it shows the high regional vulnerability to sea level rise, and underlined that projections of future regional sea-level rise are above global levels (figure 97).

273. On observed impacts on coral reefs, she mentioned: an increase in coral bleaching re-occurrence and severity; a rapid decline in the abundance of reef building corals of 1–2 per cent per year for 1968–2004; and loss of ecosystems services and impacts on the GDP of countries in the region (see figure 98). Ms. McFadzien added that **saltwater intrusion and inundation** is also a concern, especially for atolls, with observed occurrences of salinization of limited freshwater resources, increased risks to agricultural production and food security, and negative health effects. On **health**, she pointed to: increased incidences of vector-borne disease, including malaria and dengue, especially endemic dengue in Samoa, Tonga and Kiribati; health impacts of changes to water availability, including cholera outbreaks after extreme events; and increased outbreaks of ciguatera fish poisoning linked to temperature increases.

Figure 97

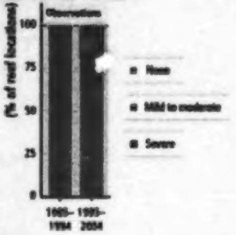
Observed sea level rise from 1993–2012



Source: Slide 4 of the presentation by Ms. Diane McFadzien (South Pacific Regional Environment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_sprep_sed4-2_feb9.pdf>. The figure shows a map of rates of change in sea surface height (geocentric sea level) for the period 1993–2012 from satellite altimetry (see Intergovernmental Panel on Climate Change Fifth Assessment Report, Working Group I, Frequently Asked Questions 13.1, figure 1).

Figure 98

Observed impacts on Pacific coral reefs



Source: Slide 5 of the presentation by Ms. Diane McFadzien (South Pacific Regional Environment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_sprep_sed4-2_feb9.pdf>. The figure shows the increase in impact on coral reefs in the Pacific from the period 1985–1994 to the period 1995–2004.

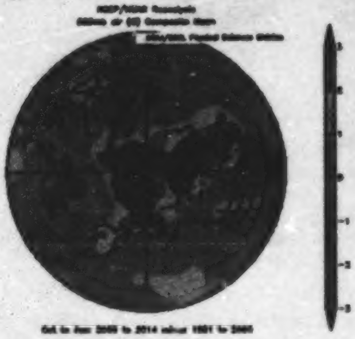
274. She underscored the **vulnerability to climatic extremes** of Pacific small islands, which rank high in relative exposure to tropical cyclones. She added that economic losses from tropical cyclones translate to losses in GDP of 15–25 per cent, hampering economic development. She outlined adaptation actions in the region, including: the strengthening of metrological services; capacity-building programmes, including the development of vulnerability and adaptation assessments, cost benefit analysis and ecosystem-based adaptation tools; the Pacific Adaptation to Climate Change project; and joint National Action Plans. She indicated that despite the very low level of emissions of countries in the region, various mitigation programmes are in place.

275. In concluding, she stressed that: the **Pacific has a substantial economic dependency on climate-sensitive sectors**, such as ecosystem services and tourism, with limited opportunities for economic diversification; **adaptation potential is limited for many of the observed impacts of climate change**; and

implementation of adaptation options, if available, **comes at very high costs** in relation to countries' national budgets.

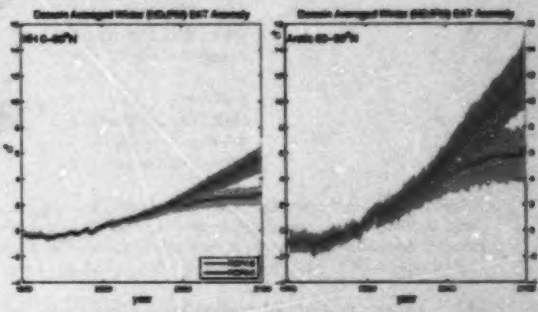
276. Mr. Lars-Otto Reiersen, Executive Secretary, Arctic Monitoring and Assessment Programme (AMAP) Secretariat, presented an Arctic perspective. He explained that the work of AMAP touches upon, inter alia: the status of the climate, climate feedbacks, the Greenland ice sheet, ocean acidification; sea ice snow cover, freshwater resources, permafrost and short lived climate forcers.

Figure 99
Arctic temperature amplification: 2-3 times changes in mid-latitudes



Source: Slide 4 of the presentation by Mr. Lars-Otto Reiersen (Arctic Monitoring and Assessment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_amap_sed4-2-feb9.pdf>. The figure shows that in the Artic the temperature increase is two to three times greater than that observed at mid-latitudes.

Figure 100
Arctic temperature



Source: Slide 5 of the presentation by Mr. Lars-Otto Reiersen (Arctic Monitoring and Assessment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_amap_sed4-2-feb9.pdf>. The figure shows that in the Artic the projected temperature increase for RCP4.5 and 8.5 is at least twice that projected for mid-latitudes.

Abbreviation: RCP = representative concentrations pathway, SAT = surface air temperature

277. On **temperature**, he explained that temperature amplification in the Arctic is three to four times greater than changes in mid-latitudes because of the **albedo effect**, i.e. the land and the ocean are absorbing more heat because of the melting of the snow and ice (figure 99). He presented new modelling graphs of the Arctic temperature based on scenario RCP4.5, which projects a 6 °C average temperature rise by 2100, and scenario RCP8.5, which projects a 12 °C rise by 2100 (figure 100).

278. He underlined the importance of the volume of the sea ice, emphasizing that the ice has become younger and thinner since the end of the 1980s, with much of the older, thicker ice in the north of Alaska now melting away during the summer. He pointed to adverse impacts of the disappearance and thinning of the sea ice on polar bears, which are congregating in the north of Canada.

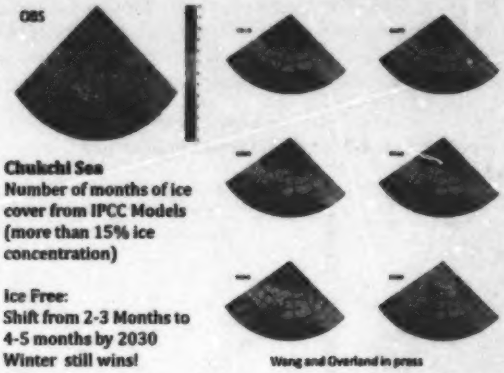
279. Mr. Reiersen then focused on **Pacific-Arctic Ocean heat storage**, pointing to an anomaly of 6–7 °C warmer waters in the straight between Alaska and Siberia. He underscored the importance of sea temperature, explaining that most of the **sea ice is melting from below**, owing to the increased sea water temperature. He presented IPCC models for the Chukchi Sea, showing a shift in ice-free months from 2–3 months per year to 4–5 months per year by 2030, and the projected total disappearance of sea ice by 2100 (figure 101).

280. He noted that the normal **Polar Vortex pattern of West to East flowing winds that traps cold air in the Arctic was broken down in December 2009** and in following years, allowing cold air to spill southwards, which partly explains recent extreme weather events in northern America and Europe.

281. On **snow cover**, he reported decreases of snow cover of up to 40 per cent in 2012 compared with 1971–2000 levels. Looking ahead, he showed projections of decreases in snow water equivalent, as well as in annual snow cover duration. On the **thawing of the permafrost**, he pointed to an estimated loss by 2100 of an average of 100 Gt of carbon from these areas (figure 102).

Figure 101

Sea ice cover in the Chukchi Sea



Chukchi Sea
Number of months of ice cover from IPCC Models (more than 15% ice concentration)

Ice Free:
Shift from 2-3 Months to 4-5 months by 2030
Winter still wins!

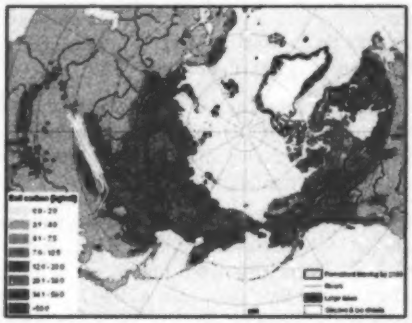
Source: Slide 8 of the presentation by Mr. Lars-Otto Reiersen (Arctic Monitoring and Assessment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_amap_sed4-2-feb9.pdf>. The figure shows the projected decrease in sea ice cover in the Chukchi Sea, over the period 2010–2090.

Abbreviation: IPCC = Intergovernmental Panel on Climate Change.

282. On the **run-off of water from Greenland**, he compared an Arctic climate assessment in 2011, which projected the water run-off from Greenland at 2 hundred Gt of water – the equivalent of the volume of approximately 1 m of water above the land mass of Australia – to the latest figures that double this amount, to approximately the equivalent of 2 m of water above the land mass of Australia, with a significant contribution to sea level rise. On **ocean acidification**, he pointed to the assessment published by AMAP in 2013, which indicated that: Arctic marine waters are experiencing widespread and rapid ocean acidification; the primary driver of ocean acidification is uptake of CO_2 emitted to the atmosphere by human activities; the Arctic Ocean is especially vulnerable to ocean acidification; and acidification is not uniform across the Arctic Ocean.

Figure 102

Reduction of permafrost by 2100



Source: Slide 13 of the presentation by Mr. Lars-Otto Reiersen (Arctic Monitoring and Assessment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_amap_sed4-2-feb9.pdf>. The figure shows the projected areas permafrost thawing by 2100 and the amounts of carbon currently trapped in those soils.

283. Noting that the Arctic is now opening up to mining, shipping and oil and gas activities, he said it faces new and emerging challenges, such as invasive species and health impacts affecting the people of the Arctic. He also pointed to the impacts of climate change and loss of sea ice on walruses and polar bears.

284. Ms. Sonja Vermeulen, Head of Research, CGIAR Research Program on Climate Change, Agriculture and Food Security, presented on agriculture and food security in a changing climate. She explained that she would

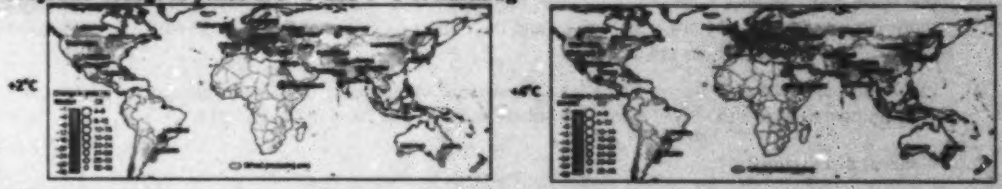
present some **key papers published after the IPCC cut-off dates**, which confirm the findings of the contribution of WGII to the AR5, in particular its chapter on agriculture and food systems.

285. She stated that **recent results**, for example from the Agricultural Model Intercomparison and Improvement Project (AgMIP)[40] **reconfirm AR5 findings** on **observed impacts** on crops, pasture and marine fisheries at global and regional levels. These findings indicated that from 1980 until 2008, negative climate impacts were observed on the yields of three of the four major crops (wheat, soy, maize), with consistent negative impacts across most regions for maize and wheat. She also recalled that the AR5 shows that by 2050, about 10 per cent of **projections** across all regions and all RCP scenarios expect a positive impact on crop yields, and 25 per cent of those studies project negative impacts, sometimes substantial. These **negative impacts are particularly concentrated in tropical areas**. She further underlined that research has focused on crops and mean impacts, with less research carried out on capacities and adaptation strategies, and on yield impacts of climate variability and extremes.

286. She then presented results from AgMIP, which aggregates 30 different models, with very high agreement among the agricultural models, relatively high agreement among downscaled climate models and fairly large differences among economic models that extrapolate impacts on food prices. She pointed to a paper emerging from AgMIP indicating that **wheat shows a six per cent yield loss for each degree of temperature rise**, equivalent to a quarter of the current global trade (figure 103).

Figure 103

Projected change in yields at 2 °C and 4 °C of warming



Source: Slide 4 of the presentation by Ms. Sonja Vermeulen (CGIAR), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/4_cgiar_sed4-2_feb9.pdf>. The figure shows projected changes in yields for 2 °C of warming (left panel) and 4 °C of warming (right panel) above pre-industrial levels. Wheat shows a 6 per cent yield loss for each degree Celsius rise, equivalent to
42 Mt or a quarter of global trade.

287. On **cash crops**, Ms. Vermeulen said they also face major impacts and shifts in growing areas, pointing to the example of regional changes in suitable growing areas for Arabica coffee in 2050, based on scenario RCP6.0. While recognizing that the 2013–2015 review is concerned with the difference between 1.5 °C and 2 °C of warming above pre-industrial levels, she stressed that **little agricultural research uses scenario RCP2.6**, and instead the higher RCP scenarios are used, particularly scenario RCP6.0 and scenario RCP8.5. In Indonesia, 84 per cent of current coffee-growing areas will no longer be at an economically viable level of production by 2050. While noting that other areas will open up, she pointed to arising adaptation issues, such as the low number of transport routes, unavailability of processing facilities, slow development of markets, etc. In Central America, she stressed that the need for coffee plantations to move up in altitude threatens areas that are protected for biodiversity and water management reasons.

288. Ms. Vermeulen then referred to a paper by Lobell and Tabaldi (2014) that finds that since **demand for food** will increase in the next 20 years, even small yield changes in that period are of major concern. She stressed that the likelihood of a 10 per cent yield loss in the next 20 years is: for wheat, less than 1 in 200 without climate change, and 1 in 20 with climate change; and for maize, less than 1 in 200 without climate change, and 1 in 10 with climate change. She drew attention to a recent paper that warns that **future food production is highly vulnerable to both climate change and air pollution**, with implications for global food security. The paper finds that **ozone** is playing an increasing role in wheat and rice production, and a lesser role in maize production.

---

[40] AgMIP is an international collaborative effort to assess the state of global agricultural modelling and to understand climate impacts on the agricultural sector.

289. On the impact of climate change on **livestock and marine fisheries**, she noted that less research is carried out in this field, and that yield outcomes for livestock depend on complex factors, particularly the availability of feed. She indicated that regional projections of rangeland and pasture yields are expected to be released during 2015. On marine fisheries, she indicated that with 2 °C of warming above current climatic conditions, yield losses are likely in Southeast Asia, Sri Lanka, Angola and Namibia, and yield gains are likely in Iceland and the southern coast of West Africa. She noted that the regions with high economic dependence on fisheries are likely to see a yield loss.

290. On **capacities to respond**, she referred to a study on empirical evidence from Brazil, Mexico and the United States of America that shows that both generic and specific capacities matter in determining food security outcomes. She stressed that both generic capacities, such as poverty levels in society and access to services, and specific capacities, such as climatic information to farmers or early warning systems, need to work in tandem. Underlining the importance of **water and water management capacities**, she cited the example of Afghanistan, where the impacts of extreme events on wheat yields can be decreased with irrigation, but will depend on the ability to maintain irrigation facilities.

291. Ms. Vermeulen mentioned that in Mexico, some breeds of heat-tolerant wheat have been able to overcome some of the heat impacts, but cautioned against the limits to these breeding interventions. She noted that "the real way in which farmers experience climate change" is in terms of **years of failure and increased risk to production**. She cited the example of Mozambique, where the fishermen have to go further off shore because of the declining fishing stocks, and are impacted by the storms that increase the risk of loss of life at sea, and that cause damages to their fishing gear, their houses and subsistence gardens. She called for substantially more work to be carried out on these risks and the impact of extreme events on farmers' livelihoods and their ability to 'bounce back' after major shocks.

292. She also referred to insufficient knowledge on the impacts of climate change on pests and disease, welcoming a call from the SBSTA to make submissions on that issue in March 2015.

2. General discussions

293. The ensuing discussion was guided by the following questions on theme 2 (subparagraphs (a–f) below) and theme 1 (subparagraphs (g–k) below) of the review:

(a) What are the most recent findings in relation to observed regional impacts?

(b) Are there regions in which some ecosystems cannot adapt naturally? Is their adaptation assisted or might it help to assist them, and by which means? What are the consequences for agriculture and development?

(c) What challenges does global warming pose to agricultural practices, policies and measures, from a regional perspective?

(d) What challenges does global warming pose to sustainable development from a regional perspective?

(e) How has progress towards the long-term global goal varied across regions?

(f) How do opportunities and barriers to adaptation and mitigation vary across regions?

(g) Which risks vary the most across regions? How do these risks vary at various levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(h) How do risks for vulnerable ecosystems vary across regions at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(i) How do regional food security risks vary at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(j) How do observed impacts including those of sea level rise and extreme events vary across regions and at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(k) What is the future of ecosystems, agriculture and sustainable development from a regional perspective, in the context of climate variability, climate change and uncertainty about future climate conditions?

294. A Party lamented the absence of a presentation on Africa, which has unique challenges. He stressed the importance of water security and suggested addressing **the mitigation co-benefits of adaptation action**, such as water desalination and mangroves. Stressing the uniqueness of the IPCC review process, he noted the gaps in regional information and expressed reservations with using emerging scientific information that is not as robust. He suggested deciding how to treat emerging data before hearing it, and further noted that the IPCC produces special reports, which deal with urgent matters and emerging information.

295. A Party asked how the indirect impacts of climate change on livelihoods can be assessed, in particular in LDCs and SIDS. An expert explained that **globally, very little food is traded**, particularly staple crops, with only 16 per cent of cereals being traded globally. She therefore underscored the importance of local food systems, stressing the need for national and subnational projections. On vulnerabilities in these communities, she said there are some well-established techniques for their assessment, pointing to work done by the International Livestock Research Institute (ILRI), which carries out assessments to identify hotspots of vulnerability to climate change. She further **stressed the importance of building small holders' own capacities**.

296. Further to a request for clarification by a Party on the annual rainfall figures presented for the Caribbean, an expert stated that the decline in annual rainfall in the Caribbean varies greatly spatially from 25 to100 inches depending on closeness to the coast, aerography and other factors. He explained that the figures presented are average declines reported by the reporting stations, mainly at airports and farming stations.

297. A Party asked what the available **options for economic diversification in SIDS** are, given the impacts of climate change on various economic sectors, in particular agriculture, tourism and fishing. An expert explained that for **tourism**, the **options for economic diversification are limited**, noting that tourism in the Pacific is driven by foreign ownership and that diversification will most likely imply moving to more appealing locations. She added that the local population will be most hit, with employment losses, in particular as coral reefs and ecosystems that attract tourism are becoming eroded. She pointed to some examples of attempts to develop cultural tourism in order to move away from coral-dependent activities.

298. A Party asked about the **links between adaptation and mitigation in the regions discussed**. An expert explained that mitigation actions in the Caribbean have been implemented as part of a larger package of adaptation and mitigation efforts aimed at achieving sustainable development. He outlined some co-benefits of mitigation action, including **savings of foreign exchange**, **lower energy rates provided to consumers**, **health benefits** and **increased energy access**. He also pointed to some co-benefits of solar dryers used by farmers, noting that their use is being scaled up. Another expert pointed to the example of the **alternate wetting and drying irrigation technique in rice cultures** carried out in China, India, Japan, Philippines and Viet Nam, which leads to adaptation and food security gains via reduced input costs for farmers, as well as mitigation benefits because of the avoided CH_4 emissions of about 48 per cent.

299. A Party asked which adaptation strategies would be appropriate in the Himalayas and if there are plans to address the information gaps identified in the AR5. An expert drew attention to similarities between the Alpine areas and the Arctic, in particular the melting of glaciers. He said some of the work carried out in the **Arctic on adaptation options** could be applied in the Himalayas. He added that very little data is available on adaptation needs in the Arctic and looked forward to cooperation with other regions facing similar challenges. Another expert indicated that research findings published after the **IPCC cut-off dates** confirm the AR5 findings, in particular in relation to the **retreat of glaciers**, **ocean heat uptake** with regional impacts and **statistics on extreme events**.

300. A Party asked if a **regional adaptation plan exists in the Caribbean region**, and if a financial assessment of the **adaptation and mitigation needs of the region** has been carried out. An expert explained that the Regional Framework for Achieving Development Resilient to Climate Change adopted by the Caribbean Heads of State includes an **adaptation** component. On financial needs, he referred to work in the region on projections, primarily on sea level rise. Some of the modelling for a 1 m **sea level rise** for the Bahamas, Belize, Guyana and Suriname combined is projected to amount to annual **GDP losses of USD 1.2 billion**; the loss of at least 16 multimillion dollar tourism resorts; USD 4 billion in infrastructure costs, with significant transportation losses at airports; and USD 5 billion for relocation loss. Another expert referred to table 16.3 in chapter 16 of the contribution of WGII to the AR5, which identifies **adaptation opportunities, constraints and limits**, and to section 16.6, which addresses mitigation and adaptation interactions.

301. A Party asked about the **economic quantification of the projected losses in the agricultural sector**. An expert said that an increasing number of studies have quantified losses incurred as a consequence of climate change, for example the projection of a loss of 42 million tons of wheat or a quarter of global trade for each degree of warming. She also pointed to a historical study on climate change impacts on wheat, maize, rice and soy between 1980 and 2008, which estimates the yield losses due to climate change, for example a 3.8 per cent global average loss, which is equivalent to 23 million tonnes or the total production of Mexico, and a 5.5 per cent yield loss for wheat, which is equivalent to the total production of France. The study also examines the impacts on food prices (e.g. 6.4 per cent increase in food commodity prices considering that carbon fertilizing of the crop has taken place or an 18.9 per cent increase without carbon fertilization). Another expert indicated that **increased yields are projected in the Arctic**, as some vegetables that could not be grown before will be produced, but stressed that this is a "**very minor positive effect**" of warming temperatures.

302. A Party asked what the **costs of the mitigation actions outlined in the presentation on the Caribbean** are, what the **costs of adaptation in all the vulnerable regions presented** are, and whether technologies are available to address mitigation and adaptation needs. An expert said that although there are some national-level studies related to costs of adaptation and mitigation, they are not comprehensive and tend to focus on particular sectors. In a study by the United Nations Economic Commission for Latin America and the Caribbean on the economics of climate change, the figures are highly variable from country to country and a gross figure is not available at this time.

303. A Party pointed to a **gap in information from Latin America**, while recognizing that representatives from that region had failed to suggest institutions that could have delivered a presentation at the meeting. He suggested that the SED 4 report mention that according to the AR5, **observed temperature over the last 20 years has increased by an average of 0.5 °C per decade, and that the rate of warming in Central America is twice the global mean**. He also referred to a recent report of the Inter-American Development Bank (IDB) titled "Climate Change at the IDB: Building Resilience and Reducing Emissions", which indicates that GHG emissions of the 26 countries of the region decreased after 2005, largely because emissions from land-use change and forestry fell by 44 per cent between 1990 and 2011, mainly as a consequence of reduced deforestation in the Brazilian Amazon. The report also finds that Latin America and the Caribbean's electricity mix is cleaner than those in other world regions.

304. Noting that the presentations confirmed the findings of the IPCC and the need for the global goal, a Party asked if changes **in urban, spatial and development planning** had been observed in vulnerable areas to address vulnerability and exposure to climate change risks. An expert underlined that issues related to **exposure** are critical, pointing to a number of initiatives in the Caribbean that aim to reduce exposure, such as the Caribbean Uniform Building Code (CUBiC) that contains provisions to reduce exposure to impacts from hurricanes and flooding. He also referred to training of country planning officers in climate change vulnerability analyses. The expert underscored the importance of governance in making adaptation more effective, citing a chapter dedicated to this issue in the Regional Framework for Achieving Development Resilient to Climate Change. He stated that insurance and reinsurance are "hugely important" in the Caribbean to lessen the risks posed by climate change. Noting the high costs of these measures, he added that they are part of a suite of adaptation approaches. Another expert described some changes in **infrastructure planning** due to climate change impacts in the Arctic, including the erosion of soft coastal areas due to loss of sea ice protecting the coast from waves, **driving populations in Alaska to migrate inland**, and thawing of permafrost affecting roads and buildings. He stated that a lesson learned from the events that will affect the North is that the average temperatures "are maybe not the most interesting", the **important indicators are the extremes**.

305. While recognizing that having a presentation of all the regions was not feasible, a Party suggested that the 2013–2015 review be informed by the volume on regional information of the contribution of WGII to the AR5. An expert described the strategy adopted by **WGI to address the regional aspects of climate change**. He said that for the first time, WGI took a process point of view to better understand the future impact on affected regions of climate process modes, such as El Niño or the Pacific oscillation, along with long-term trends. He indicated that the chapter also includes an atlas of 37 regional projections, available in digital form, which provides data for three time horizons and all four RCP scenarios, on temperature and precipitation anomalies. He specified that the atlas covers in detail the African and Mediterranean regions and provides data relevant to droughts and water shortages. The expert also mentioned the Coordinated Regional Climate Downscaling Experiment (CORDEX) that covers 14 regions, with regional scale models, providing 'fine-grain' information

and the emerging Coupled Model Intercomparison Project Phase 6 (CMIP6) effort. He underlined that in the near future, the WGII community will have increased access to a lot of new physically based information relevant to regional impacts and risk studies. Another expert added that the contribution of WGII to the AR5 includes a full volume on regions, with nine regional chapters, including one on oceans. He pointed to chapter 21 of that volume, which is an introduction that explains the caveats on the regional aspects. He added that the information presented: is mainly from WGII, with an introduction outlining WGI information; addresses non-climatic stressors, such as land-use changes and socio-economic conditions; and includes some aspects coming from WGIII.

306. Mr. Clifford Polycarp (GCF) explained that the GCF is "now shifting gears to move to full scale operations". He said that in 2014, the Fund focused on mobilizing resources and reached a target of USD 10 billion. In order to **start committing resources**, he stressed the need for: each country to designate a **national focal point** responsible for all GCF operations and engagement in that country – approximately 50 countries still have to designate one; **institutions to be accredited to the GCF**, according to its standards, which are differentiated according to a 'fit for purpose' accreditation criteria, with the first batch of accreditation expected at the Fund's Board meeting in March 2015; and **proposals for projects and programmes from the accredited institutions**, which should be in line with the country's priorities, support at least one of the Fund's eight strategic results, and meet the Fund's six funding and investment criteria. He added that the Fund's eight strategic results cover all sectors, and that overtime, the GCF will need to: maintain a 50-50 balance between adaptation and mitigation; maintain a regional balance; and allocate 50 per cent of its adaptation funding to SIDS, LDCs and African countries.

307. He indicated that over the coming months, the GCF will develop more detailed guidelines on these requirements and processes. For several countries, capacities will need to be built or strengthened to enable them to access the Fund's resources and use them effectively. Mr. Polycarp explained that the Fund can already start to provide **readiness support to strengthen the designated national authorities**. He reported that the Fund is in 'active dialogue' with approximately 50 countries on their possible proposals, with about a dozen concrete proposals being developed.

308. In concluding, he underscored the importance for designated national authorities to be in place in all developing countries, a diverse range of public and private entities to be accredited, and a handful of projects to be approved by the GCF Board before the end of 2015.

309. A Party asked if a global warming of **2 °C or 1.5 °C** above pre-industrial levels would imply the passing of some **thresholds in the Arctic**. An expert explained that 2 °C warming on the global level would imply a temperature **change of twice that amount in the Arctic**. He underscored the importance of **the speed of change**, which affects the ability of animals to adapt, in particular those linked to the ice. He added that new species are already appearing in the Arctic region at current levels of warming. In the oceans, new species are coming in, such as mackerel and will "fight" with traditional species of the Arctic.

310. A Party asked if research had been carried out on: the impacts of climate change on **crops like sorghum, beans** and others that contribute significantly to the GDP of African countries; the impact of parasites on these crops and the impact on livestock; and the associated adaptation costs. An expert indicated that substantial impact studies on major crops such as sorghum, beans, yams and cassava, have been carried out in Africa. She added that research on livestock in general, as well as on pests and disease, is a weak area.

311. A Party pointed to the **limits to adaptation**, in particular in relation to the risks posed by **sea level rise and climate extremes to ocean ecosystems**, and asked how these risks amplify with the ongoing warming, and how they threaten the ecosystem goods and services provided. An expert stated that the services provided by marine ecosystems can be either marketed or non-marketed. He cited the example of coral reefs that provide sand for beaches and absorb, reflect and dissipate wave energy from high energy events. If they are lost, countries would have to replace them by coastal engineering protection measures that are extremely costly. These costs could be a barrier for many island States. He also mentioned the services provided by mangroves, including habitat for fish and filtering of land-based contaminants. He explained that putting a dollar value on fisheries is much easier than other ecosystem services that are equally critical, and that only indicative values are available. The expert also referred to the cultural importance of ocean and coastal areas, noting that in some Pacific islands some coastal cemeteries have been lost.

312. A Party noted that while the higher emissions RCP scenarios are used in agricultural studies, they make projections to 2050. Given that the warming level for all these scenarios is similar in the near-term he asked if these results can help illustrate the differences between 1.5 °C and 2 °C of warming. An expert agreed that in broad terms, in the higher emission scenarios, the global temperature can be expected to be approximately 2 °C warmer in 2050. She also drew attention to the fact that the AR5 refers to a temperature increase of 2 °C as a tipping point in terms of impacts on agriculture, particular in temperate regions.

313. A Party asked for more information on the solutions to address the increasing pressures on freshwater supplies, in particular the challenges associated with precipitation changes and salt water intrusion. He asked if they had explored some solutions, such as desalination and the challenge it poses. He also asked if the CTCN is working in Africa or the Near East on this issue. An expert explained that a wide range of solutions to address freshwater scarcity had been implemented in the Pacific region, stressing that no "one size fits all". She referred to work on demand-side management, such as measures to address leakages, and supply side management. She also outlined challenges related to the development of rainwater harvesting, such as land tenure issues or the inadequacy of traditional roofs to collect water. She stated that desalination is "the least popular option" because of its high costs. Another expert added that although desalination has been seen as a panacea for coping with freshwater stress in small islands, some of the challenges associated with this solution include: management of the risks associated with the disposal of the brine; its negative impacts on marine ecosystems where there is poor disposal of the brine, for example too close to the shore; and its high energy intensity. However, he also mentioned a successful desalination project of the CCCCC in Saint Vincent and the Grenadines powered by photovoltaic energy, which produces a surplus of energy.

314. A Party asked if lessons could be learned from a study of 2014 on the unique situation of the corals living in the bays around Palau's Rock Islands, where coral reefs thrive despite acidic oceans. An expert said that it may be too early or too difficult to extrapolate from the findings of that "perplexing study" across other reefs, adding that the reefs in question have adapted to the increasing acidity of the water over a very long timeframe. In contrast, existing reefs will have to adapt over decades, to a much higher rate of acidification. He also said that it is not clear if those coral will survive in water at lower acidity. Another expert underlined that the variability of conditions affects the comparability of situations. He said that the reefs in the study may be able to survive in water with high acidity because of the absence of other pressures, or that the acidity of the waters may only be slowing the rate of their growth, which would impact their recovery between bleaching events. In the absence of bleaching those corals were not tested on how rapidly they could grow. He stressed that this local study requires further investigation.

315. A Party asked for more details on the **existing mitigation possibilities in the agricultural sector**, and if any **initiative exists to promote and share good practices in this field**. An expert explained that direct emissions from the **agricultural sector account for approximately 12–14 per cent of global emissions**, with livestock management, rice management and agricultural soils as major subsectors. She also stressed the role of agriculture as a driver of deforestation. She identified hotspots for mitigation opportunities, including **managing water levels in rice cultures**, which comes with economic benefits, or **changing feeding regimes and managing herd sizes in ruminants**. She underlined that the greatest mitigation potential is in relation to the **carbon stored in the soil**, but that technically, it is difficult to raise the level of carbon in the soil. On good practices, she explained that CGIAR is working on **climate-smart villages** where farmers and researchers test packages of interventions, such as water management techniques, weather-based insurance and the provision of weather services to farmers.

316. A Party asked which are the **GCF's priority areas in mitigation** to ensure that its resources will be channelled to those activities that have the highest impact, and how does its approach differ from that of the GEF. In particular, she asked to what extent the decarbonization of the energy and industrial sectors is reflected in the GCF priorities. An expert explained that the GCF results framework includes four areas on mitigation: energy, transportation, forest and land use, and buildings and cities. While stressing that the GCF will have to support emission reduction activities in all four areas, he stated that considering the significance of the energy sector, many demands are expected from it.

317. A Party asked how much of the USD 10 billion pledged to the GCF has been deposited. He also referred to the difficulties faced by some national financial entities in disclosing fiduciary information, which may be requested in order to be accredited with the GCF. He then asked about how the GCF was planning on mobilizing adaptation funding, and how the 50 per cent of resources to be allocated to adaptation was going to be carried

out, either through a ceiling over the whole portfolio of the GCF or on a regional basis. An expert explained that the process of realizing the pledges into agreements is underway, and that the GCF aims to have 50 per cent of the pledged amount deposited by the end of April 2015. On **fiduciary requirements** for entities seeking accreditation with the GCF, he said the Fund uses an online application system, assuring that all the confidential information disclosed will be treated as such. On the **adaptation window**, he indicated that there is no decision from the COP or the GCF Board on this issue, and that the adaptation projects and programmes could come from any source. On the **distribution of projects**, he said the current targets are at the portfolio level, and that the Fund is to ensure regional balance among projects, but does not have any specific numerical target.

318. A Party asked about the status of the request by COP 20 to the GCF Board to accelerate the operationalization of the adaptation and mitigation windows, and to ensure adequate resources for capacity-building and technology development and transfer, as well as the status of the development of a monitoring and accountability framework for the GCF. An expert explained that underlying the Fund's results framework is a performance measurement framework that will be accompanied by indicators, including the number of people affected by the project. He added that work on the development of the performance measurement framework started in 2014 and is still ongoing.

F. Part 4: Emerging information

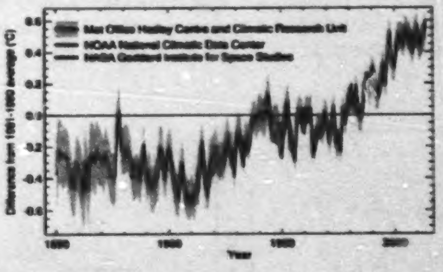
1. Presentation by experts

319. Mr. Rajendra Pachauri, IPCC Chair, was unable to deliver his presentation as scheduled. A copy of his Power Point presentation is available on the 2013–2015 review page on the UNFCCC website.[41]

320. Mr. Deon Terblanche, Research Director, WMO, delivered a presentation on behalf of Mr. Jerry Lengoasa, WMO Deputy Secretary-General, on the current state of the climate and updated information published after the IPCC cut-off dates for literature to be considered for the AR5. His presentation addressed the latest evidence on the observed state of the global climate, knowledge of GHGs in the atmosphere and how to address knowledge gaps.

Figure 104

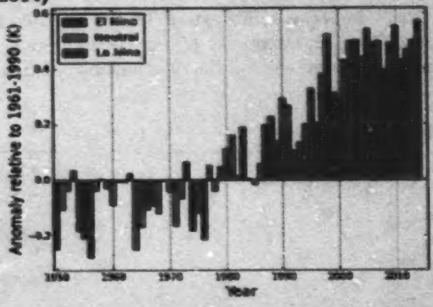
Global average temperature anomaly (1850–2014)



Source: Slide 3 of the presentation by Mr. Deon Terblanche (World Meteorological Organization), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/6_wmo_sed4-2_feb9.pdf>. The figure shows the increase in global average temperature since 1850, and that the 2000–2010 decade was the warmest on record.

Figure 105

Global average temperature anomaly (1950–2014)



Source: Slide 5 of the presentation by Mr. Deon Terblanche (World Meteorological Organization), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/6_wmo_sed4-2_feb9.pdf>. The figure shows that 2014 ranks as the warmest year on record, in particular in the absence of El Niño.

---

[41] See: <http://unfccc.int/7521.php>.

321. He described a graph showing the **global average temperature anomaly** for the period 1850–2014, stressing that, according to the calculation method used, 2014 was the warmest year on record. He underlined that not only was 2014 the warmest on record, but in addition, it was not an El Niño year (figure 105).

322. **On the oceans**, he indicated that averaged global sea surface temperature for the period January–December 2014 was estimated at 0.48 °C above the 1961–1990 long-term average, a record high value. The 2014 average of the ocean heat content estimated for the 700 m and 2000 m layers was higher than for any earlier year on record.

323. From the work of the World Climate Research Programme (WCRP), of which WMO is a co-sponsor, he cited an article that presents evidence suggesting that as the **Arctic continues to warm faster than elsewhere** in response to rising GHG concentrations, the frequency of extreme weather events, such as cold spells, stormy periods, heat waves and droughts, caused by persistent jet-stream patterns will increase. He underlined that what happens in the Arctic has implications "way beyond the Arctic" with impacts at mid-latitudes and beyond.

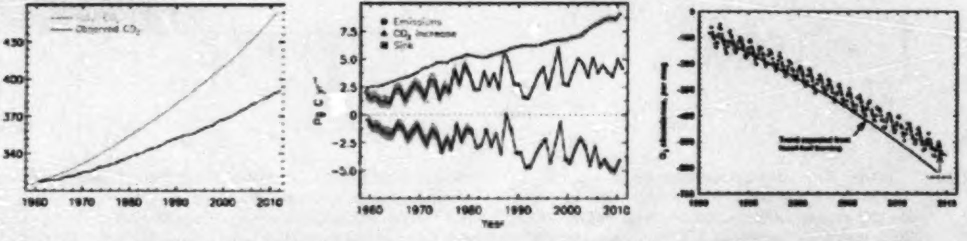
324. **On GHG concentrations in the atmosphere**, he referred to the WMO Global Atmosphere Watch (GAW) programme, which aims to provide high-quality observations of the chemical composition of the atmosphere and improve the understanding of the increasing influence of human activity on the global atmosphere. He stated that: atmospheric CO_2 continues to increase every year, a trend largely driven by fossil fuel emissions; atmospheric CO_2 levels were above 400 ppm at the Mauna Loa observatory for three months beginning in April 2014 for the first time; and the growth rate of CO_2 concentrations varies greatly from year to year with the global growth rate between 2012 and 2013 the largest since the current global record started in the 1980s. The growth rate has been increasing on a decadal basis, as inter-annual variability is largely driven by the sinks of the Earth system (ocean and biosphere).

325. On the **complexity of the carbon cycle**, he presented three graphs showing the expected increase in atmospheric CO_2 based on the total emissions compared with the observed values in the atmosphere (figure 106, left-hand side panel); anthropogenic emissions, sinks with strong inter-annual variability, and the resultant increase in atmospheric CO_2 (figure 106, middle panel); and observed slow decrease in oxygen abundance in the atmosphere due to the burning of fossil fuels, which can be used to discriminate between ocean and terrestrial biosphere sinks (figure 106, right-hand side panel). He explained that improving observations will enable better quantification of the sources and sinks, stressing that knowledge of terrestrial and ocean sinks is essential for better understanding the anthropogenic contribution.

326. On **ocean acidification**, he also reported an upward trend in ocean acidity at a few sites, despite the lack of a global representative figure. He underscored the need to standardize the measurements in the atmosphere and the oceans with the aim of achieving common calibration standards.

Figure 106

The carbon cycle



Source: Slide 10 of the presentation by Mr. Deon Terblanche (World Meteorological Organization), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/6_wmo_sed4-2_feb9.pdf>. The figure shows: the expected increase in atmospheric CO_2 based on the total emissions compared with the observed values in the atmosphere (left-hand side panel); anthropogenic emissions, sinks and the resultant increase in atmospheric CO_2 (middle panel); and the observed changes in oxygen abundance in the atmosphere due to the burning of fossil fuels (right-hand side panel).

327. He stated that society is attempting to advance efforts to reduce CO_2 emissions and will likely do so even more in the future; mitigation efforts will vary by country, region and emission sector, and be diverse in their approach; **the complexity of the carbon cycle is such that tracking the adequacy of aggregate measures to achieve the long-term global goal will require considerable monitoring system enhancements**; and emission

reduction approaches require independent, scientific monitoring to support verification and policy decisions. He then outlined gaps in the current integrated observing system, including: insufficient density of observations over land, the sea and in the free atmosphere; insufficient measurements of isotopes and co-emitted gases for source attribution; incompatible observations on different scales and in different media (e.g. atmospheric observations versus partial pressure CO_2 observations); and insufficient complexity and performance of transport models on global, regional and local scales. He stressed the need for a comprehensive GHG information system that would include atmospheric, oceanic and land measurements. This would imply that WMO/GAW and the Global Climate Observing System, which oversee most of the long-term atmospheric measurements, and other organizations, which oversee the oceanic and land measurements, work together to that end.

328. In concluding, he underscored the need for: the **development of the observing system in all domains**; investment in observation in the atmospheric domain due to its role in mixing, transport and radiative forcing in order to obtain maximum benefits in the short term; the development of the modelling tools to deliver products on the temporal and spatial scales relevant to decision-making; collaboration between the 'spheres', i.e. atmosphere, oceans and biosphere; and inter-agency coordination.

2. General discussion

329. A Party underscored that global measurements of CO_2 in the atmosphere not only indicate an upward trend, but also an **increasingly upward trend**. He stated that "if one message comes out of the review process, it has to be that **we are not on track to deliver 2 °C**". An expert explained that about half of the total GHG emissions have been absorbed by the oceans and the terrestrial biosphere, but pointed to the great inter-annual variability of the sinks, as well as the great amount of uncertainty in terms of how the oceans and terrestrial biosphere will react in future and the risk that this entails.

330. A Party asked for views on findings published after the IPCC cut-off dates on the **instability of the east Antarctica ice sheet**, and that its irreversible retreat may be triggered at low levels of warming, leading to higher projections in sea level rise. An expert indicated that WGI placed a large emphasis on looking at new comprehensive assessments of sea level rise, as reflected in the scoping exercise that proposed dedicating a chapter of the WGI report to this issue. He said that the chapter on sea level rise enabled the group to collect the expertise in the scientific community in a comprehensive manner. He stressed that sea level rise estimates and projections widely varied in the scientific literature assessed, with various model types used to project sea level rise, some fully based on physical processes, others being semi-empirical models. The author team was able to provide projections for the end of the twenty-first century for the first time including all relevant components: the thermal expansion of the water due to warming; the melting of the large ice sheets, Greenland and Antarctica; as well as the melting of glaciers and storage use changes. Recognizing that science has progressed since the IPCC cut-off dates, he said the new results published would not lead to a full revision of the IPCC assessment, but rather add interesting details that strengthen the possibilities outlined. He added that if instabilities are triggered in ice sheets, this could lead to a sea level rise of up to 7 m by 2300 over a millennium if the Greenland ice sheet is sent on a pathway of total melt down. He also stressed that the AR4 thresholds were revised downwards in the AR5, and that the IPCC gave low confidence to the possibility of a large amount of the Greenland ice sheet melting at 1 °C of warming above pre-industrial levels. He underscored that the new emerging science is limited to observation, highlighting the importance of understanding ocean warming and its interaction with the ice sheets. He concluded that the possibility of potentially higher sea level rise and the new scientific findings will have to be assessed in the next IPCC cycle. Another expert added that satellite observations are becoming increasingly important in the field of sea level rise, calling on satellite agencies to invest in the capabilities to monitor ice sheets and sea levels. A third expert indicated that AMAP is in the process of updating the latest assessments from 2011, which will be presented in March 2017, supporting the need to improve the network for observations in the Arctic, as well as the models which enhance our understanding of feedbacks.

331. A Party **cautioned against using non-IPCC information**. Mr. Fischlin underlined that Parties may ignore information that has not been assessed rigorously enough, but said that they may also take it into account in a risk-management context. Another Party underlined the importance of looking at the long-term trend, noting that while the IPCC is "the gold standard", the review process should be open to other sources that can help increase our understanding of climate change.

332. A Party asked about the **uncertainties related to the findings that 2014 was the warmest on record.** An expert explained that in the past decade, we have had a number a very warm years (2014 was the warmest but was very close to 2010 and 2005). He stressed the importance of the general trend and comparing on a decadal basis, which clearly indicates an upward trend. Mr. Fischlin asked if the new findings on 2014 change the trends published by WGI in the summary for policymakers in its contribution to the AR5. An expert indicated that the observations for 2014 had not been assessed by the IPCC yet, underlining the distinction among observation, information and assessment. He said that establishing the value of global temperature change is difficult, stressing that large areas of the globe are unobserved, and where information has to be interpolated. While recognizing that there is uncertainty, he stated that there is high probability that 2014 was indeed the warmest year on record. He underscored the importance of trends over individual years, emphasizing that the WGI approach is decadal averages, and that "we are looking at a series of years that are, altogether, the hottest over the past 60 years". He added that the fact that El Niño had no part in the warming, and that nonetheless 2014 was the warmest on record, is important to note.

333. A Party asked about the **relationship between temperature and CO_2 concentrations**, which produces a linear relationship. Noting that there are thresholds that, if passed, will cause severe irreversible impacts, he asked if the review's focus on the linear relationship makes us disregard some other key severe risks and threats. An expert said there is no simple linear relationship between actual or current CO_2 concentration in the atmosphere and the current global mean temperature. This near-linear relationship does exist between cumulative CO_2 emissions and projected temperature rise in the twenty-first century. He pointed to figure 10 of the summary for policymakers in the AR5 SYR, which brings together the unique assessment of risks in five categories, associated with information from WGIII on required emission reductions.

G. Closing

334. Mr. Zou Ji outlined some reflections on the work carried out by the SED and its role within the science–policy interface. He reminded participants that the SED had held five meetings since its inception, in conjunction with meetings of the subsidiary bodies. He outlined a few common aspects of all SED meetings, and commented on the dialogue that had taken place over the four sessions of the SED. He stressed that all meetings of the SED shared some common aspects, both procedural and of substance, which he said illustrate the transparent, participatory and balanced way the meetings were organized and carried out, as well as the robustness of the science presented.

335. First of all, all meetings of the SED were open to all Parties and observers. Second, their organization was always based on submissions by Parties, and the SED co-facilitators published an information note ahead of each meeting to ensure the transparency of the organization of the meetings. Third, SED meetings were organized as a fact-finding exchange of views between experts and Parties. He indicated that a total of 60 presentations were made by 73 experts. The experts presented findings from the AR5, relevant reports and work of United Nations organizations and others, as well as bodies under the Convention, highlighting their relevance to the 2013–2015 review. While noting that a majority of IPCC experts were invited to present at SED meetings (33 of the 73 presentations were made by IPCC experts), he expressed his belief that this reflected the fact that the AR5 is "the most robust and authoritative assessment of climate science to date", and that decision 1/CP.16 specifically mandated that the review be informed by IPCC sources.

336. Mr. Zou Ji added that a significant number of non-IPCC experts were also invited, and that the geographical, cultural and gender balance among invited experts was always respected. He stressed that non-IPCC experts presented, in a balanced manner, information sources from United Nations agencies and other international organizations, as well as observed regional impacts of climate change.

337. He then addressed the format and substance of the discussions. Mr. Zou Ji underlined that the presentations made at SED meetings were always followed by a moderated discussion that addressed guiding questions and questions from all participants. Furthermore, at all SED meetings, the amount of time allocated to discussions was significant, always exceeding that allocated to the presentations themselves. The meetings were all well attended, bringing together many government delegates and experts from all regions, as well as civil society representatives. He stressed that delegates engaged in a remarkably constructive, productive and rich manner in all discussions with experts, often asking follow-up questions that deepened the debate. He also underscored that at SED 3 and 4, experts presenting in one part also attended other parts of the session, allowing for linkages to be made among presentations, and the interrelation between adaptation and mitigation to be well

addressed. He therefore stated that the SED discussions were "very rich and substantive, balanced, and carried out in a transparent way".

338. Mr. Zou Ji remarked that all SED meetings addressed the two themes of the review in a balanced manner, in terms of the time allocated to them, as well as the format and content of the presentations and discussions. He noted that summary reports on SED 1, 2 and 3, and all presentations and audio and video recordings of the meetings are available on the 2013–2015 review web page.

339. In terms of content, Mr. Zou Ji said the SED had considered a wide range of sources, covering adaptation, mitigation, finance, technology and capacity-building issues. These sources included the contributions of all three working groups of the IPCC to the AR5 and the SYR, and the work of various processes and bodies under the Convention, namely the Adaptation Committee, the Standing Committee on Finance, the CTCN, the TEC, the GCF and the SBI. The SED also heard from United Nations and other organizations, namely the GEF, UNEP, FAO, IEA, the World Bank and WHO. Experts from various regional organizations and regional centres also presented at SED 4.

340. In concluding, Mr. Zou Ji stated that these common traits of the SED sessions illustrate the robustness, transparency, integrity and reliability of the work of the SED. He emphasized that these aspects of the SED meetings have placed it in a position to fulfil its main mandate, namely to ensure the scientific integrity of the 2013–2015 review. He thanked Parties, the secretariat and his co-facilitator for their support and engagement in the work of the SED.

341. Mr. Fischlin made some reflections on the work of the SED and its role within the science–policy interface. He outlined a number of ways in which the SED had brought closer together the policy and scientific communities. He recalled that as mandated by the Parties, the SED had taken into account "the best available scientific knowledge, including the assessment reports of the IPCC". He indicated that this mandate had been fulfilled, since at SED 2, 3 and 4-1, the SED supported Parties in internalizing the key findings contained in the contributions of the three Working Groups of the IPCC to the AR5 and the SYR.

342. He added that at SED 1, 2 and 4, the SED supported Parties in internalizing key findings contained in landmark reports emerging from the recent work of United Nations organizations and other organizations. While underlining that all these findings were relevant to both themes of the 2013–2015 review, he stated that the SED thus facilitated their consideration in a broad and comprehensive policymaking context.

343. Mr. Fischlin then referred to Article 2 of the Convention, in particular the objective to achieve the stabilization of GHG concentrations in the atmosphere "at a level that would prevent dangerous anthropogenic interference with the climate system". While noting that what constitutes a 'danger' is subjective, he stressed that it is our common fear of the threat of climate change that "brought us all together under the Convention", by agreeing on avoiding that danger. On the other hand, he added, Article 2 "divides us", since people may differ on what constitutes danger, and global climate change is impacting us all in different ways. He explained that Article 2 calls for sound information upon which to act after having decided whether the risk is too high, in other words too dangerous, or whether it is an 'acceptable' risk.

344. Mr. Fischlin underlined that the above is what the SED achieved. He stressed that at SED 3, IPCC experts indicated that assessing the adequacy of the upper limit for global warming in the light of Article 2 of the Convention involves both risk assessments and value judgments. He added that risk assessment is what science can provide, sound information on possible dangers. Yet, values also need to be taken into account, which leads to choosing from policy options. Therefore, he said, we need the scientific information, which enables us to make the policy choices. He underscored that in the AR5, the IPCC assessed risks across contexts and through time in a most comprehensive manner, hereby providing an analytical framework that can now be used as a foundation for a collective agreement on how much global warming we choose to accept or tolerate while considering all implications. He expressed confidence that through the SED much of this framework had been mobilized, enabling us now to make these policy choices.

345. In concluding, he expressed the hope that the SED had "empowered" Parties "by informing and supporting policy formulation, not only within the 2013–2015, but also on the road to Paris, taking into account the various values and recognizing that what constitutes an intolerable risk may well differ across sectors, regions and countries". He thanked experts, the secretariat, Mr. Zou Ji and the Parties for the many "excitingly fruitful discussions" that had been held within the SED.

Annex V

Statistics regarding the organization of the structured expert dialogue

	Total	SED 1	SED 2	SED 3	SED4-1	SED4-2
Submissions[1]	20[2]	8[3]	3[4]	5[5]	2[6]	2[7]
Time of SED Sessions	34.5	3	6	12	6	7.5
Presentation Time	15.5	1.5	2.5	4.5	2.75	4.25
Discussion Time	19	1.5	3.5	7.5	3.25	3.25
No. of Presentations	60	10	10	16	12	12
Overarching	27	0	1	2	12	12
Theme 1	17	6	4	7	0	0
Theme 2	16	4	5	7	0	0
No. of Experts	73	4	11	18	18	22
Overarching	43	0	1	2	18	22
Theme 1	26	3	5	18	0	0
Theme 2	27	1	8	18	0	0
Presenting	53	4	9	16	12	12
Responding Only	20	0	2	2	6	10
IPCC Experts	33	1	6	16	6	4
Other Experts	40	3	5	2	12	18
Gender[8]	53M:20W	4M:0W	8M:3W	12M:6W	13M:5W	16M:6W
Discussions						
Questions from Parties	263	7	50	89	63	54
Overarching	111	0	6	13	38	54
Theme 1	67	4	14	40	9	0
Theme 2	85	3	30	36	16	0
Responses from Experts	331	15	46	114	87	69
Overarching	147	0	11	12	55	69
Theme 1	77	7	8	50	12	0
Theme 2	107	8	27	52	20	0

Figure 107: Presentation vs. discussion time

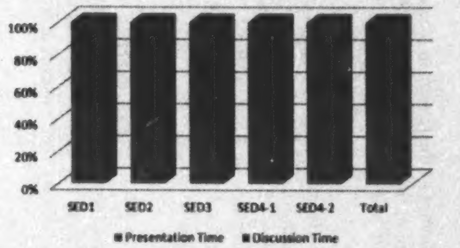


Figure 108: IPCC experts vs. others

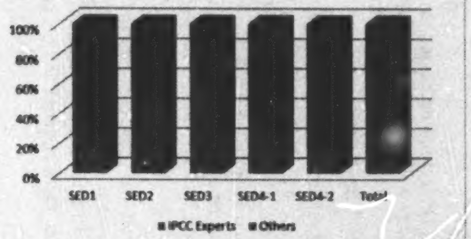
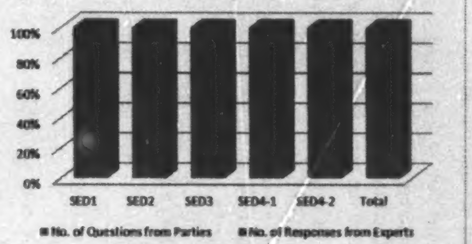


Figure 109: Questions vs. responses



---

[1] Available at <http://unfccc.int/7590.php>

[2] Submissions received from 18 Parties and 2 NGOs

[3] Views on the available information that should be considered at SED1 from 6 Parties and 2 NGOs

[4] Views on the further work of the SED from 3 Parties

[5] Views on the future work of the SED, including the further use of different sources of information from 5 Parties

[6] Views on additional inputs to the SED, on how to conclude the review and on the final [illegible]ng of the SBSTA and the SBI to COP 21 from 2 Parties

[7] Views on the resumed fourth session of the SED from 2 Parties

[8] M = men and W = women

Annex VI

List of experts participating in meetings of the structured expert dialogue

Expert	Affiliation
Amena Yauvoli (SED 4-1, 4-2)[1]	Chair of the Subsidiary Body for Implementation
Andreas Fischlin (SED 1, 4-2)	ETH Zurich, co-facilitator of the structured expert dialogue (SED)
Zou Ji (SED 1, 2, 3, 4-1, 4-2)	Renmin University of China, SED co-facilitator
Keith Alverson (SED 4-1)	United Nations Environment Programme (UNEP)
Alexander Baklanov (SED 4-2)	World Meteorological Organization (WMO)
Vicente Ricardo Barros (SED 4-1)	Intergovernmental Panel on Climate Change (IPCC) Co-chair
Florent Baarsch (SED 4-1)	UNEP
Joern Birkmann (SED 3)	IPCC
Diann Black-Layne (SED 2)	Chair of the Standing Committee on Finance
Gabriel Blanco (SED 3)	IPCC
Christina Chan (SED 4-2)	Co-chair of the Adaptation Committee
Renate Christ (SED 4-1, 4-2)	Secretary of the IPCC
John Christensen (Sed 4-1)	UNEP
David Cooper (SED 4-2)	Secretariat of the Convention on Biological Diversity (CBD)
Purnamita Dasgupta (SED 3)	IPCC
Robert Dixon (SED 2)	Global Environment Facility (GEF)
Kris Ebi (SED 4-1)	World Health Organization (WHO)
Ottmar Edenhofer (SED 3, 4-1)	IPCC, Co-chair of IPCC Working Group III
Christopher Field (SED 1, 3, 4-1)	IPCC, Co-chair of IPCC Working Group II
Luis Gómez-Echeverri (SED 3)	IPCC
Jonathan Gregory (SED 2)	IPCC
Stéphane Hallegatte (SED 4-1)	IPCC
Michael Hanemann (SED 3)	IPCC
Taka Hiraishi (SED 2, 3, 4-1, 4-2)	IPCC, Co-chair of IPCC Task Force on National Greenhouse Gas Inventories
Juan Hoffmaister (SED 4-2)	Co-chair of the Adaptation Committee
Christina Hood (SED 4-1)	International Energy Agency
Christian Huggel (SED 3)	IPCC
Krishna Kumar Kanikicharla (SED 2)	IPCC
Sivan Kartha (SED 3)	IPCC
Reto Knutti (SED 2)	IPCC
Volker Krey (SED 3)	IPCC
Corinne Le Quéré (SED 2, 4.1)	IPCC
Paul Leadley (SED 4-2)	CBD secretariat
Boram Lee (SED 4-2)	World Climate Research Programme
Jeremiah Lengoasa (SED 1, 2, 3, 4-1, 4-2)	WMO

---

[1] "SED 4-1", for example, stands for the 1st meeting of the fourth session of the structured expert dialogue (SED), while "SED 3" simply means the third session of the SED.

Jason Lowe (SED 1)	Hadley Centre
Katharine Mach (SED 4-2)	IPCC
Diane McFadzien (SED 4-2)	Secretariat of the Pacific Regional Environment Programme (SPREP)
Alexandre Meybeck (SED 4-1)	Food and Agriculture Organization of the United Nations
Leo Meyer (SED 4-1)	IPCC, Head of IPCC Fifth Assessment Report (AR5) Synthesis Report Technical Support Unit (TSU)
Axel Michaelowa (SED 3, 4-2)	IPCC
Guy Midgley (SED 4-2)	IPCC
Jan Minx (SED 3, 4-1, 4-2)	IPCC, Head of IPCC Working Group III TSU
Maria Neira (SED 4-1)	WHO
Leonard Nurse (SED 4-2)	Chairman of the Board of Governors of the Caribbean Community Climate Change Centre
Anne Olhoff (SED 4-1)	UNEP
Lennart Olsson (SED 3)	IPCC
Balgis Osman-Elasha (SED3)	IPCC
Antonio Pflüger (SED 2)	Chair of the Technology Executive Committee
Ramon Pichs Madruga (SED 4-1)	IPCC, Co-Chair of IPCC Working Group III
Gian-Kasper Plattner (SED 4-1)	IPCC, Head of IPCC Working Group I TSU
Clifford Polycarp (SED 4-2)	Green Climate Fund
Hans-Otto Pörtner (SED 3, 4-1)	IPCC
Lars-Otto Reiersen (SED 4-2)	Arctic Monitoring and Assessment Programme
Joeri Rogelj (SED 4-1)	IPCC
Joyashree Roy (SED 3)	IPCC
Asunción Lera St. Clare (SED 3)	IPCC
Thomas Stocker (SED 2, 4-2)	IPCC, Co-Chair of IPCC Working Group I
Deon Terblanche (SED 4-2)	WMO
Griffin Thompson (SED 2)	UNEP, Climate Technology Centre and Network (CTCN)
Petra Tschakert (SED 4-1)	Penn State University / Coordinating Lead Author of chapter 13 of contribution of Working Group II to the AR5
Jukka Uosukainen (SED 4-2)	UNEP, CTCN
Penny Urquhart (SED 3)	IPCC
Sonja Vermeulen (SED 4-2)	Consultative Group for International Agricultural Research / Research Program on Climate Change, Agriculture and Food Security
Detlef van Vuuren (SED 2, 3)	Integrated Assessment Modelling Consortium
Koko Warner (SED 3)	United Nations University
Phillip Williamson (SED 1, 2, 3, 4-2)	CBD secretariat
Jean-Pascal van Ypersele (SED 4-1, 4-2)	IPCC Vice-Chair
Sergio A. Zelaya (SED 4-2)	Secretariat of the United Nations Convention to Combat Desertification